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THE PRE-INCARIAL RUINS OF TIA HUANACO, IN BOLIVIA, FORMERLY UPPER PERU.

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(With a Coloured Plate.)

Two routes, both from the shores of the Pacific, may be recommended to the traveller who desires to explore these most ancient monuments. One route is from Arica by railway to Tacna, then by mule up the western slopes of the Cordillera, and across it to the Desaguadero, or outlet of Lake Titicaca, from which river the ruins of Tia Huanaco are distant twenty-seven miles. However, a far more interesting road, though longer, is from Lima, when the traveller would have the opportunity of visiting the temple and city of Pachacamac on the coast, the work of a nation conquered by the later Incas. Ascending the Cordillera, Incarial ruins will be met with continually; the native suspension bridge of ropes over the deep chasm in which runs the river Apurimac will be crossed, after which Cuzco will be entered, still glorious in its ruins of edifices belonging to the times of the Incas; but unlike the very much more ancient, which I propose to call the Pre-Incarial, remains of Tia Huanaco, the work of a period we know nothing of, either historically or traditionally.

Going from Cuzco south, until the great basin of Lake Titicaca is reached, the country is inhabited by Quichua, or, as they are sometimes called, Inca Indians; but around Lake Titicaca, its islands, and vicinity, live the Aymará people.*

* Markham, in his *Travels in Peru and India*, while superintending the collection of Chinchona plants and seeds in South America, and their introduction into India says, that according to Calancha (1653), a rock called Titicaca gave its name to the island and lake; *titi* being the Aymará for a cat, and *caca* for a rock, for on this rock a cat (wild) is said to have sat with fire starting from its eyes. In Quichua *titi* means lead. On this rock, which is at the west-end of the island of Titicaca, there was an altar, where the Aymarás adored the sun, and near it were

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Near to the south end of the lake are the extraordinary monuments about to be described. They are within sight of the road from the Desaguadero to the city of La Paz, twelve miles from the southern end of Lake Titicaca, in 16° 42′ south, 68° 42′ west, and 12,930 feet above the level of the sea. At the period of the conquest some of the walls, we are told, were washed by the waters of Lake Titicaca; these waters are now some twelve miles distant, and 135 feet below the base of the ruins.

The present hamlet of Tia Huanaco, containing about a hundred and twenty habitations—the greater number now deserted—is within sight of this interesting spot, in a north-west direction.

The existence of such a collection of stone-remains at an elevation of nearly 13,000 feet above the level of the sea is rather surprising; and from the writer's personal experience of the neighbouring *puna* region (Andean tableland) of Tarapacá, such an elevation is not propitious to animal or vegetable life, and we wonder, and ask for an explanation, why this seat of an ancient and peculiar civilization should have been placed at such a height. It may be a subject for speculation and inquiry as to what was then the nature of the climate and soil to have produced sustenance for the builders of these monuments. They are sometimes, but erroneously, called Casas, or houses of the Inca.

DESCRIPTION OF THE RUINS.

I. The Great Mound (for there is another artificial one near to it) is at present of a hill-like form, of 918 feet in length, with a breadth of about 400 feet, 100 to 120 feet in height, and some accounts state it to be built on a solid or stone foundation.

Early Spanish writers called it a pyramidal structure, and from the large quantity of stone ruins on it, they supposed that there might have been a fortress and buildings thereon, as well as a temple on its summit. The base of the mound is surrounded by large stones perfectly worked, a number of which have been taken away, especially to build the present church of Tia Huanaco.

II. The pilasters are also called pillars, obelisks, and porticoes. Castelnau observes that some are worked, others are in the rough, and are of a hard sandstone and green granite; they are not square, but squared, and it has been thought that some of them may have served as a gallery to a large building which

three idols joined in one, called *Apu Tuti* (the chief sun), *Churip Tuti* (the son's sun), and *Tutip Hauqui* (brother of the sun).

It seems certain that, from emblems found carved upon the ruins and from tradition, the worship of the sun and moon was established amongst the Aymarás for ages before the conquest of their country by the Incas of Cuzco.

once may have existed behind them. They are from eighteen to twenty-one feet in length, some three to four feet being in the ground, and several "métres" apart (the métre is 3·2809 English feet). A range of these is seen placed round the great mound. In a drawing in D'Orbigny, and in the recently-taken photograph by Helsby and Co., of Valparaiso and Liverpool, there is the appearance as if horizontal pieces had connected them, by being let in on the top of the pilasters; if so, what a magnificent Peruvian Stonehenge! A height of eighteen to twenty feet would give a width of four feet by two and a-half to three feet thick.

III. Remains of large slabs of worked stone, supposed to have been a hall of justice. D'Orbigny says there are three, and composed respectively of hard sandstone, trachyte, and basalt, and that some of the slabs are joined by metal clamps. Rivero and Tschudi observe that each slab has three seats cut out; and that numberless pieces of stone of all sizes, wrought into square, cruciform, and triangular figures, and many of them grooved, as if for windows and doors, lie about there; some have been united by metal clamps, the metal having been run into cavities made for that purpose. Castelnau speaks of the slabs as four sets of seats, each being about thirty-six feet square, and five feet thick. They are to the north-west of the mounds.

In some drawings of these slabs they look as if of a more recent date than the pilasters, portals, and other remains.

According to Castelnau there is in advance of the slabs a series of stones showing admirable workmanship, and he says that we wonder at the means which were employed, or by what sort of tools. The present Indians say that the original builders had a plan of softening stone by the application of certain herbs!

IV. The broken sculptured monolith portal is N.E. of the seats of justice. Thanks to Messrs. Helsby, we have now a photograph of this most interesting monument. (See drawing.) In the photograph the portal is seen broken into two unequal portions and partially buried in the ground. Mr. Pentland informs me that it has sunk much (or rather earth has collected round its base) since he saw it in 1834; he also tells me attempts have been made to break it up for mill-stones. It would appear that it stood on its own solid foundation. D'Orbigny gives the following dimensions for this portal:—Above the ground it is 10 feet; in width, 13 feet 3 inches; of one block of hard trachytic rock; the doorway 6 feet high. The eastern face has three lines of sculptured figures in alto-relief of men, and figures of men with bird's heads; each line has sixteen figures, and in the centre a larger sculptured human figure; the west face

has no sculptures. The two niches below (Castelnau calls them "cavités transversales) appear to have had doors with copper hinges. D'Orbigny thinks the figures with human heads denote kings, those with the condors' heads "savage chiefs," or the condors may be considered as the sun's messengers, or attendants on the kings. The figures with human and bird's heads look towards the principal central figure. All the figures are highly ornamented with heads of birds; those with heads of men have fourteen heads of birds, and three more on the staff; the bird-headed figures have seventeen heads of birds, and three on the staff.

In vol. ii. p. 22, *Viage á las dos Americas*, there is a drawing of this portal. It is given entire, and three lines of human figures are drawn, which is incorrect, for the figures of the centre line have heads of birds.

If this portal stands on its own solid foundation, it may have been cut out of a block of stone of some 600 tons.

Ere the builders of Tia Huanaco could have arrived at such sculpture as is seen on the portal, a long period of time must have elapsed. The alto-reliefs on the portal and the work on the statues are something wonderful, when we consider that the sculptors, it is generally believed, had no tools of iron.

Dr. Manuel Guerra, formerly Prefect of La Paz, tells me that at his silver mines of Kimsachaca, eight miles from the ruins, there is a monolith portal, which has been taken there from Tia Huanaco.

V. The colossal stone idols appear to have stood on the north side of the mound. Gibbon, in Part ii. of *Exploration of the Amazons*, in 1851, says that at the gateway of the church of Tia Huanaco were standing two heavy stone idols, with their hands crossed. Castelnau mentions that two great idols, male and female, stand now before the cemetery of the village, and crowned with a sort of turban. He also adverts to another colossal head, and a lizard carved on blocks of stone. The lizard, after the condor, seems to have been a favourite device of the ancient Aymarás. Rivero and Tschudi give the following dimensions of one, most probably of the large colossal heads:—From the chin to upper part, 3 feet 6 inches; in diameter, 2 feet 7 inches. Say this was one-fifth of its height, it would give about 18 feet high and 4 feet in diameter. D'Orbigny tells us that they are of basalt, covered with sculptures in bas reliefs. There are human figures with fish or lizard-like tails on the head. There are eight human figures in front on the neck; the hands are very small, and just below the neck; an upturned moustache-looking ornament; large eyes, with apparently three smaller eyes below each eye; long downward-curved nose; and heads of birds like

the condors. Old Spanish writers describe these statues as having robes touching the ground, with their "tocados" or ornamented head-dress, the whole very much worn by time, which proved their great antiquity. Near to one of these idols some gold was found by the first Spaniards.

According to Garcilasso, between the pilasters and the wall that surrounded the great mound there were stone statues of men and women, as natural as life; some with cups in their hands drinking; others seated and standing; others as if passing a stream, which ran through the edifice: there were other statues of women with children in their laps, on their backs, and many other ways.

VI. A cyclopean wall of stone appears to have encompassed the great mound inside a range of pilasters. Acosta measured a block of stone of this wall, of 30 feet in length, 18 feet in width, and 6 feet thick; this Linton, in his *Colossal Vestiges of the Older Nations,* calculates at 200 tons. (However, some of the stones in the fortress at Cuzco, of Incarial work, are 50 feet in length, 22 feet broad, and 6 feet thick. Such masses of stone would weigh about 1000 tons.)

This may be the wall that was washed by the waters of Lake Titicaca, when Cieza de Leon was there, somewhat before 1550. He was born in 1517, lived seventeen years in America, and died 1560.

VII. Cieza de Leon is the first to speak of the monolith building, and if we can credit what is said of it by the Cura Alcobaza, a friend of Garcilasso's, this must have been one of the most wonderful monoliths known. Cieza says it is "An edifice the walls of which only remain, some of the stones much decayed by time."

Alcobaza wrote to Garcilasso that it consisted of a square court of 15 brazas (the braza is equal to a fathom or six feet), equal to 90 feet, and its walls two estados, or 12 feet high. On one side of the square court was a hall 45 feet long and 22 feet broad, the walls 9 inches thick, covered in imitation of a straw thatch, which is of stone (like that of the Temple of the Sun at Cuzco); the said court, with its walls, pavement, hall, stone thatch, portals, and thresholds of two doors belonging to the hall, and another door of the court-yard, *all this is of one mass of stone only.* The Indians told Alcobaza that this building had been dedicated to the Maker of the Universe.

Our elements for calculation are, a court-yard 90 feet square, its walls 12 feet high and 9 inches thick. The hall is 45 feet in length and 22 feet broad. If the whole of this was cut out of a solid body, such a mass could not have been less than a square of 90 feet, by 12 feet thick. Now if we take the cubic foot of this sort of stone at 200 lbs., and multiply the

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area of one side by one edge, we shall get at a result, namely—a monolith of 8,678 tons!

Linton gives for the weight of the temple of Latona, at Buto, in the delta of the Nile, 5,000 tons; but this temple dedicated to the Maker of the Universe at Tia Huanaco was of superior magnitude by 3,678 tons.

It strikes me that this monolith building may have stood to the north of the great mound, and not far from it, inside the range of pilasters in which stands the sculptured monolith portal, and on the square spot in front of the mound, as seen in Plate IX. in D'Orbigny.

VIII. Old writers speak of the very large edifices, palaces, and temples of stone, of 656 and 328 feet in length, east and west, with their angular colossal columns, which probably mean the pilasters; in particular of a palace built of large blocks of stone, some of them 28 feet in length, over 13 feet in width, and over 6½ feet thick. D'Orbigny says that the palaces were to the east of the mound. The portals, or rather the door-ways, were perpendicular, and not like the Incarial, which inclined inwards towards the top.

Castelnau states that there are some subterranean canals amongst the ruins.

Rivero and Tschudi allude to very large masses of stone, so cut, that, when resting on each other, their junction formed a channel; these were examined by Don Manuel Guerra in 1846, when excavating here: he found some idols, one was three and a-half yards in length and half a yard in width; also some sculptured masses of large dimensions which have served to make stones for grinding chocolate.

D'Orbigny speaks of a figure like a sphinx, which, I should think, is the side ornament of a door; of figures like jaguars with the mouth open, and a hole drilled through the sides; and of animals of stone with holes cut in them, as if used for lamps, or rather for holding offerings. Castelnau notices a very large salamander in stone, and a colossal head, on the road before he got to the ruins, coming from La Paz.

The last visitors to the ruins of Tia Huanaco, who took an interest in them, were Mr. Helsby and his assistant in 1857, and to Mr. W. G. Helsby, of Liverpool,* I am much obliged for two photographs taken from daguerreotypes. One is a view of some of the pilasters, nine in number; the other is a view of the monolithic portal, now broken, said to have been split by lightning. (See drawing.) They found the surface of the mound covered with the remains of masonry, some with circular

* Carte de visite size views of the ruins of Tia Huanaco, as well as many others connected with South America, may be procured from Mr. W. G. Helsby, Church Street, Liverpool.

grooves. There was also a small stone portal upright, of some eight feet in height; it formerly lay on the ground, when the people of La Paz tried, but failed, to take it away to their city. Mr. Helsby had much difficulty in getting the Indian guide to sit on a stone by the side of the broken portal whilst he was operating; and when the Indian saw his likeness on the plate, he took to his heels and ran off. All they found there was a small copper object like a candle extinguisher, and a double-headed stone hammer.

I have been informed by Mr. Pentland that he made drawings and a plan of the ruins of Tia Huanaco, but these and his observations are still in MS.

He likewise told me that a gentleman, named John Bowring, visited Lake Titicaca and the ruins about 1834, and made drawings, supplying copies to D'Orbigny. On reference to the *Comptes Rendus*, 1839, p. 584, there is a letter from Mr. Pentland on the priority of Bowring as having surveyed the Lake Titicaca and made other investigations in that region.

Near to the ruins are two square towers like tombs, of Colla or old Aymará work. There are remains also of an Incarial palace, which may have been built by Mayta Capac, the IVth Inca, or by his son Yupanqui. Mayta Capac reigned thirty years, dying about 1156 A.D. He conquered the Collas, and being here when he received news, brought in great haste by a Chasqui or foot messenger, is said to have exclaimed, "Tia" or "Tiai Huanaco," which in the Quichua language means, "Rest or sit thou fleet as the Huanaco." It is asserted that this Inca built a wall thirty miles in length, extending from the Cordillera to Lake Titicaca.

There are vague traditions that Tia Huanaco was built by white and bearded men! that the city was reared in a single night by an invisible hand, that it was never finished! that it was destroyed, and the inhabitants turned to stone for having stoned a man to death who passed that way! also for having refused hospitality to Manco Capac!

Another is, that after the waters of the deluge had subsided, there appeared a Being who divided the country into four parts, giving them respectively to Manco Capac, Colla, Tocay, and Pinahua.

We, however, know that Mayta Capac came south from Cuzco, conquered the Collas (mountaineers), or Aymarás, and was in all probability the first Inca to behold the ruins of Tia Huanaco.

Lorente, the author of a recent *Historia del Peru*, alludes to a tradition that a king named Huyasutus built Tia Huanaco, and that its ancient name was Chuachua.

A Bolivian friend of mine tells me that "Chua Chua means

clear water, in Aymará." We are informed that a stream of water ran on each side of the mound; if so, they probably also ran through the city, and Chua Chua may mean the City of clear waters. These waters would be, most probably, clear and sweet compared with the generally brackish waters of Lake Titicaca, which came up to the walls of the place.

Then, as to the meaning of Huyusutus, the same friend informs me that *Huyu* means a hall. Can we say the halls, palaces, or city of the chief or King Sutu or Sutus?

There is much to be learnt from a careful examination of the names of places, mountains, rivers, etc., in this region, these generally expressing some marked peculiarity connected with them.

The quarries which supplied the stone for this place are distant, and blocks are still to be seen on a track in the direction of the lake. As there are caverns under the ruins, it has been supposed that some of the building material was extracted therefrom. A friend of mine accompanied Dr. Tschudi in 1858 to the ruins, when the doctor attempted to get down into a cavern, but was glad to be pulled out, as he soon became suffocated.

We feel pretty sure that neither the Aymará or Quichua Indians had tools of iron, but they had of copper, bronze, and even an alloy of copper and silver.

We do not know how they quarried such large masses of stone. Could they have resorted to a method known in the East Indies, that of cutting a groove along a rock, heating the groove with fire, sweeping the fire off, and then throwing cold water on the heated surface, which would split the rock? or could wooden wedges have been used; these kept wet with water, and by their expansion split the rock?

Independently of the devastating hand of time and that of the Spaniard, as this region was, and is still, a great centre of volcanic and earthquake action, these may also have assisted in ruining and dismembering the once great, and to us enigmatic city called Tia Huanaco.

It can scarcely be doubted but that Manco Capac was of Aymará origin. Wars may have disorganized an old Aymará empire, under which Tia Huanaco was built. Manco Capac may have had to fly for his safety from the shores of Lake Titicaca, wending his way north with his Aymará civilization, to which he or his advisers added the idea that he was a child of the sun; and he may have brought together the tribes about Cuzco, including the Quichuas.

Garcilasso says, the tradition of the origin of the Incas from Tia Huanaco was entertained by the people south and west of Cuzco, but that the Indians of the east and north had the

tradition that the Incas first appeared at Paucatambo, or came from there.

The so-called secret language of the Incas was in all probability the Aymará, or one of its dialects; still there seems to have been a more ancient language spoken in earlier times in this country. This appears from the circumstance that there are many words preserved in the Aymará region, as in the names of the principal icy peaks of the Andes of Bolivia, which I am informed are not Aymará or Quichua, as the mountains of Illimani, Illampu, Tacori (Tacora), and others ending in *ri*.

This Tia Huanaco, we may say, was the capital of an old Aymará nation. To have formed such a nation the people must have been warlike, and have extended their country through years of conquests. Then, like all other great states, it had its rise and fall, and then broke up. We have said that Manco Capac may have descended from these Aymará kings; he goes north, founds a state at Cuzco, and his successors having become powerful under another form of civilization, including particularly the worship of Inti, or the sun, these new views are the prime movers in all their wars of conquest, one route of which was south into the Aymará country, where they find the most determined and prolonged opposition to their inroads.

The Incas do not appear to have ever entirely subdued the Aymarás; but with the idea that they, the Incas, had come from the region of Lake Titicaca, they built a temple to the sun on an island in the lake, which was to them a Mecca.

We know that the Aymará language was very different to that of the Quichua, so was the religion, the style of architecture and sculpture, and to this time the Aymarás continue to be a very different people from the Quichuas or Inca Indians. At the present day the Aymará stonemasons are much sought after in other portions of Peru.

Mr. Markham observes, in his *Peru and India*, "The forefathers of the present Aymarás established a civilization of which we have no records, save the silent evidence of those cyclopean ruins of Tia Huanaco and others."

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AN ENTOMOLOGICAL RAMBLE.

BY W. E. SHUCKARD.

THE main object of this article is to show how much may be observed, and collected, and enjoyed entomologically within a very short range, and in close proximity to the metropolis, not even further than Hampstead. It is to be remembered, that I, essentially a Hymenopterist, had my observation attracted mainly by that highly interesting order of insects, which, for the satisfaction of the uninitiated, it may be as well to state comprises the large group that includes the bees, wasps, and ants; consequently the most elaborately organized, and those whose instincts are most admirably developed of all insects, although the systems abnegate their claims, giving undue precedence to the Coleoptera, or beetles. The Hymenoptera have always four membranaceous, pellucid wings (for the circumstance of some being wingless is usually merely a sexual distinction, and one of those eccentric vagaries which meet us at every turn of Nature, that defy any satisfactory theoretical explanation, receding abruptly as they do from the consecutive series of the normal type), a large and smaller one on each side, which cohere longitudinally at their edge in flight by means of a row of small hooks, and are then spread at right angles with the body, and with them they beat the air; in repose these lie lengthwise down the back, and in some, viz., the wasps, the superior wings take, at rest, a longitudinal fold, the real object of which peculiarity is not to be readily detected; for even the solitary species possess it, and therefore it cannot result from any necessity, or convenience to the social genera in the structure of their nests; besides, it does not occur at all among the bees, either social or solitary. All that we can say is, that Nature knows best; for what do we know? We but grope about in the dark, through which, sometimes, at rare intervals, a faint glimmer momentarily lights the obscurity.

Having vindicated to my favourite order of insects the supremacy due to them, and which I claim for them as their right on behalf of structure, vivacity, and intelligence, I can assure the young entomologist that a bright summer's day's collecting at Hampstead will furnish his cabinet with a choice store and number of the species and genera of the order, provided always that he uses due diligence, and has eyes to see; for the degree of the education of the eye of the practical entomologist is the main means to the successful pursuit of his labours. But practice will greatly develope this faculty,

as it does everything else, and in time he will see and find what an unpractised companion would vainly look for.

In starting for Hampstead, my path lay through the intervening fields of Camden Town, where I did not loiter, for my object being the *Aculeate Hymenoptera* I did not search the hedgerows for other families. It is rarely before half-past seven or eight that the aculeates are upon the wing: but in the broken ground beneath these hedgerows, where several species of *Halicti*, large and small, burrow, and where several *Andrenæ* occur, I have constantly captured the common species of *Nomada*, viz., the *Goodeniana*, *Marshamella*, etc., also the small *Sheppardana*, *infuscata*, and *pusio*, vaulting about in front of the entrance of the burrows of *Halictus rubicundus*, *minutus*, *minutissimus*, *Morio*, etc.; whose exit the *Nomadæ* no sooner observed but these interlopers entered to deposit there their own eggs, to the detriment of the rightful progeny, very many of the *Aculeate Hymenoptera* being parasites—which implies that they deposit their eggs in the nests upon the food stored for the development of the issue of the insect whose labours have collected it, and which their issue consume, to the starvation and consequent abortion of the proper heir. It was in these fields that I first discovered the aromatic and agreeable odour exhaled when caught by the *Nomada Goodeniana*, *Marshamella*, etc., which is of a pungent balsamic character. But many Hymenoptera emit peculiar odours; the little wood-boring *Hylæi* send forth a very sharp but agreeable citron smell, some of the *Halicti* a lusciously sweet but sickly smell, some of the Ichneumons offensive smells of garlic, or still more disagreeable scents; but the capacity is not always co-extensive with the size of the insect, for the smallest sometimes emit it more powerfully than larger ones; nor is it a peculiarity limited to this order, for many of the beetles, and bugs, and caterpillars of the Lepidoptera possess the same property. Thus the *Cicindela campestris* exhales a strong smell of the otto of roses, as does also the musk beetle (*Cerambyx moschatus*), and both exude at the same time a milky fluid which adheres to the fingers; the *Necrophori*, or burying beetles, exhibit a strong smell of musk, some of the *Staphylinidæ* an agreeably sweet smell, for instance, *Philonthus;* in others it is most disagreeable and offensive, and amongst the larvæ of the Lepidoptera there are many which give out peculiar odours, for instance, that of the Goat Moth, which feeds within the substance of the ash, is named from the circumstance of its offensive smell, which has all the rankness of the smell of the goat, and may be detected at a distance from the tree wherein it is feeding. I have also found a whole copse of willows emitting the strong and refreshing fragrance of a garden of roses, it being abundantly inhabited

by the *Cerambyx moschatus*. I merely advert incidentally here to these facts, to show that the emission of odours is not limited to the Hymenoptera, and it is presumable that Nature has furnished it as an auxiliary defence to protect them from their natural enemies; and yet it would scarcely seem restricted to this purpose from the circumstance above stated respecting the musk beetle, in which case it may be a sexual seduction; but *retournons à nos moutons*, for it is quite time that I should now have reached Hampstead Heath, where, enjoying a few balmy minutes upon the summit of the first acclivity up which I have toiled, ascending from Pond Street, where a small clump of firs yields a pleasant shade, and whence may be seen Highgate and its pretty church, whose spire stands boldly out in the blue sky, and whence also a very extensive view may be obtained of the well-wooded undulations of Essex.

My path lay towards the Vale of Health, and passing beyond the inclosures of the grounds and gardens of the mansion which lie to the left of this clump of firs, a bare, sandy continuation of the flat level of this first tableland leads to the valley, and upon this sandy level the first exhilarating indication of the entomological profusion of the district is obtained. I am speaking of a day in the beginning of June, with the wind westerly, yet merely indicated by the slow sailing of a few pellucid clouds across the blue vault of the sky; for, mind you, I speak from woful experience, if the wind blow from any point between north and east, you will look in vain for Hymenopterous insects, or meet with only a few stricken wanderers which wonder why they are abroad, and seem to think, by their desultory flight, of cramps and rheumatism like our poor frail selves, and have not that business-like promptitude and urgency upon the wing which propel their movements when the wind is in the more genial quarter. Here, then, our jocund spirits rejoice at the sight of the ground literally swarming, over a space of about fifty yards, with the little intensely black and hairy *Panurgus ursinus*, the first genus of true bees, which are distinguished from the other large division of *Apidæ*, viz., the *Andrenidæ*, by the double folding of the tongue, detected by the Rev. William Kirby; and it may be as well to observe, that it was throughout this large family that the same respected entomologist (whose admirable labours, conjointly with those of his talented friend, Mr. W. Spence, have done so much towards making entomology an esteemed science in this country, and whose work is a monument of patient research, indefatigable industry, and luminous views) first observed the remarkable sexual peculiarities of structure in the *Aculeate Hymenoptera*, of their having in the male sex one joint more in the antennæ, and one segment more in the abdomen, than in the females.

Here, then, *Panurgi* abound in such profusion that you cannot step without treading upon them, as some, issuing forth from their burrows, which are made perpendicularly in the sand, and others returning covered and laden with yellow pollen collected from the neighbouring composite flowers, look like little sweeps gaudily trimmed out on May-day with garlands of daffodils; and here in the vicinity the lazy males are sleeping or basking, curled up amongst the petals of these flowers, whilst hovering over the burrows in watchful impatience, their pretty parasite, the *Nomada Fabriciana*, may be found in almost equal abundance. And I would here just observe upon the assumed scarcity or abundance of insects, that although some insects may not be produced individually so numerously as others—this exclusively depending, as I assume, upon the function they specifically exercise in the economy of Nature—yet I have always found, even of rare species, a very sufficient number when I have happened to hit upon what I may designate as their metropolis, from the analogy of man herding collectively in those centres, and of which I shall have several instances to adduce in the course of this paper. Leaving the height, and descending through the broken and picturesque ground, studded with the golden whin in full blossom, towards the pond at the bottom, which, by the by, abounds with water insects, about half way down, lying a little to the left, I came upon my elegant species of *Andrena*, the *A. longipes*, which I often had a notion was semi-social, for I have seen several individuals constantly frequenting the same burrows, which are made obliquely in the sand, and in almost contiguous proximity. They occur in as great profusion as the *Panurgus*, so that many hundreds might be caught in a very brief space of time, though exclusively females, for I have rarely discovered the males of the *Aculeate Hymenoptera* numerous at their respective metropoles, but have usually found them scattered amongst the neighbouring flowers, or jaunting about upon the sunny side of the leaves of shrubs or hedgerows in the vicinity. Just below this spot, and before coming to the pond, I have found both males and females of the bee *Anthophora retusa*. In these, dissimilarity of sex is remarkably conspicuous. The female is of a deep brown black, with golden polleniphorus posterior tibiæ; whilst the male is of a rich olive brown with a yellow nose, and whose intermediate tarsi are singularly long and slender, and fringed with a thin feathery edging. These insects were in such abundance that I could have filled hats with them, and of the male I was very insatiate, it being such an elegant creature. *Andrenæ* also occur in this spot, as well as the beautiful *Melecta punctata*, with its black burnished body, and series of milky white spots on each side of the abdo-

men, decreasing in size to the apex, like the buttons of a lady's dress.

I have often been much amused at observing with what vehemence and pertinacity this cuckoo bee is assaulted by the female *Anthophora*, which endeavours courageously to prevent its entrance to her burrows, and in the combat they have fallen rolling upon the ground, whence they have risen after a shake, and flown off, urged by the impulse of their instincts; and although the *Anthophora* is much the largest insect, the *Melecta* is the more agile opponent, and, like a belted knight, looks formidable in its bright armour. No satisfactory theory seems to meet the difficulty of the parasitical *Aculeate Hymenoptera;* and although Pelletier de St. Fargeau endeavoured to frame one upon the presence or absence of spines externally upon the posterior tibiæ, and upon which he based his classification, it does not hold good, being contrary to experience in many cases, and he could not apply it to the bees. Here we find *Apidæ* parasitical upon *Andrenidæ;* to instance no more than one, that pretty insect the *Epeolus variegatus*, is parasitical upon the *Colletes fodiens*, and where this burrows it is in abundance, and is as numerously accompanied by the *Epeolus* as is the *Panurgus* by the *Nomada*. Here we have also the true bee upon the pseudo-bee; and as in the case above-mentioned of the *Anthophora*, we have the true bee upon the true bee, as also in the case of *Nomada Schæfferella*, which is parasitical upon *Eucera longicornis;* and in *Sphecodes* we have the pseudo-bee upon the pseudo-bee, as that rears its young at the expense of *Halictus*. I think, but I am not certain, that each parasite has its specific insect to prey upon, although in several instances I know that some have more than one parasite, nor are they all restricted to the same family, for the *Chrysididæ*—those sparkling gems—are frequently parasitical upon the bees, although more frequently upon other *Aculeates; Mutilla* is parasitical upon *Bombus*, and this in *Psythyrus*, a very similar hairy bee to itself, has its own peculiar cuckoo.

But from this interloping digression I will return, and now find myself edging the pond in the hollow, bearing to the right; and in the broken ground between the fields and the houses in the Vale of Health, which is threaded by a pathway leading across the heath, and skirting the inclosures of Lord Mansfield's park, there is one shallow pit where my choicest captures have been made; for there I have taken as many as eight specimens in a very short space of time, of the hitherto rare *Methoca Ichneumonides*, the male of which (formerly called *Tengyra Sanvitali*, before they were identified as the same species), is still more rare, and which I have caught there but twice. Its flight is very peculiar, being excessively rapid, and it requires great

promptitude to secure it, and when it alights it runs along with immense velocity, very much like some of the *Staphylinidæ*, twisting its abdomen about with agility; the female is apterous, it being one of the solitary *Heterogyna*. I consider this insect to be the European analogue of one large section of the *Thynni* of New Holland, for it has similarly-constricted segments of the abdomen, and curved joints to its long and slender antennæ; and the males, like many of those males, a curved hook at the extremity of the abdomen, and I presume its habits are the same, but with which I am not acquainted. Like them, too, in most cases, the males are black, whilst the females are fulvous, bright brown, or red; but Nature is very eccentric frequently in the great disparity of the sexes, whilst in other instances it is remarkably uniform, the reason of which we shall never unravel; but viewing it in a Darwinian light, is it a convulsive divergence towards the formation of a new species, which has rested abortive when half accomplished? This fails to be confirmed by never finding the normal or uniform type whence the start has been made. In fact, our collections are enlarged enormously in the number of species, and even genera, by these sexual differences, which prevent our collocating the dissimilar forms and the divergences of colour until direct experience gives us its assistance, and we are repeatedly in doubt as to the correlative affinity of a vast number of insects, a doubt we shall probably never solve; thus, even the female of the common European *Myzine* is not yet known, and which must certainly be apterous. In this same sand-pit I captured *Myrmosa melanocephala*, but never its black male, and also *Mutilla calva*. Upon the fences, gates, and hedges which have a sunny aspect, and which separate the heath from the adjoining private property on the left, a great many of the *Crabroes* swarm, particularly the *cribrarius* and the *patellatus*, also the genera *Pemphredon*, *Trypoxylon*, *Diodontus*, *Ceratophorus*, *Passalœcus*, in most of their species, a good many of the *Pompili*, and very many of the wood-boring bees.

The ground now gradually ascends, and on the elevated plateau which intervenes between the Vale of Health and the road leading to Highgate, *Mimesa bicolor* and *equestris*, and *Cerceris arenaria*, which in flight looks extremely large, and also an abundance of the *Ammophila sabulosa* occur. They are all engaged in conveying their prey to their burrows, as pabulum for their young, that of the *Cerceris* being *a curculio*. And here it is most interesting to watch the assiduity with which the *Ammophila* and the *Pompilus viaticus* drag along their prey of spiders over every obstruction. When interrupted they drop the prey, and take a reconnoitering survey. If they extend this too far and thus lose it, they have to hunt up and down to recover it, which they do with great pertinacity. To try them I

have sometimes removed the spider, and it is then curious to watch their painful and useless labour, which they will not intermit until they have carefully gone over every inch of the ground, and then even very reluctantly.

A fine harvest may be made upon this flat, but nothing very rare is found, excepting perhaps the *Psen equestris;* several *Oxybeli* occur in profusion, also many of the dipterous parasites of the Aculeates; and there is one, a little silver-faced fellow, who has not the least fear of the stings of his exasperated foes. Passing now across the high road to Highgate, the Heath descends very abruptly, is very much broken, and is studded with many clumps of furze all in full bloom, interspersed with occasional levels which have their little pools of water alive with water insects. This side, from its aspect, which is northerly, does not abound with the Hymenoptera, but retrieves in quality the dearth of quantity; for upon a small acclivity—bending to the south, and dotted with sparse and stunted furze, and having on its brow on the edge of a sand-hill a dwarf oak, whose gnarled roots thrust their knees in all kinds of grotesque shapes through the slightly superincumbent soil, which has been gradually abraded by the weather—I have taken amidst the furze, not on it, the beautiful and conspicuous *Hedychrum roseum* and the *Arpactus tumidus*, as also the *Nysson trimaculatus*, all in numbers. To the left, in a wide open space of this portion of the heath, I found the metropolis of what was once the rare *Astata boops*, but which my captures made common. In this species the female is less frequently found than the male; both are handsome insects, the female much resembling in form the *Larra anathema*, whilst the male, in the smallness of its conical abdomen, the enormous size of its eyes, which occupy nearly the whole of the head—in this much resembling the male of the honey-bee—is very peculiar. He is further remarkable amongst the *Aculeate Hymenoptera*, as selecting the centre of a clear space a few yards in diameter to settle upon some small clod there, whence he makes a wide circuit in the air, returning repeatedly to the same spot. These are the few Hymenoptera I have caught on this side of the heath, but nowhere throughout the heath have I taken any species of *Gorytes*, but one *Nysson*, one *Tachytes*, and neither *Mellinus* nor *Philanthus*. Abundance of *Bombi* occur, as also several *Psithyri*, and of course the nests of the former, as well as the habitation of several of the ants, upon the skirts towards the cultivated ground. The other side contains the gold-fields for collectors; but I would remark even with respect to this profusion of insect life, that it appears to be intermittent, not uniformly the same every season, and seems to follow laws irrespective of barometrical or thermometrical influences, it is between the

hours of ten and four that they chiefly abound. I have not alluded to the very many genera and species of the other orders that may be found here under propitious circumstances. I was exceedingly fortunate in the peculiarity of the day, which was in a season when May was really May—sunny, and balmy, and beautiful, the hawthorn at the very commencement of the month exhaling the rich odour of its clusters of flowers. By this time it was past six, and I was fairly tired, and my spirits exhausted from continued excitement; I repaired to "Jack Straw's Castle" to have a chop and glass of stout, and whilst this was preparing, I took a furtive glance at my choicest captures, being careful to shut the windows for fear of any escaping; but it is interesting to let one or two at a time loose, for they fly to the panes of glass, and thus their different modes of progression may be watched quietly, and they themselves can be recaptured at pleasure. Speedily finishing my simple repast, I gathered up my gear and walked leisurely back over the heath, retracing mentally all the varied sensations of the day, and enjoying, as I was recrossing the meadows homewards, the beautiful sunset with the rapidly-varying opaline tints of the sky, the progressive mutation of sunlight into twilight, and that into the gray semi-luminous beauty of a summer's eve verging into night, with the lustrous moon shining above, and inspiring the incense of the fresh-mown hay, which made the air balmy with its fragrance.

MARINE AQUARIUM.

WITH TIDAL ARRANGEMENTS.

THE so-called "mania" for aquaria may have passed away, though the taste remains in intelligent circles, and those who desire to acquire a knowledge of marine animals still persevere in attempts to domesticate them, and occasionally with more success than is generally supposed or known.

A description of one of the most successful tanks, and its system of management, may not be uninteresting to such as have only failures in the like pursuit to regret, and, from the delight expressed by many who have seen the aquarium about to be described, perhaps to readers generally.

The public exhibitions in London of aquaria, constructed when the taste was first developed, are not altogether satisfactory. It seems, therefore, proper to consider if something better cannot be done, and to ascertain if practical experience, observation, and common sense have not now added their maxims to those principles which theory in the first in-

stance suggested. Some few attempts in such a direction have been made in this country, almost in all instances by amateurs. One aquarium also, on nearly the same principles as will be described below, only worked by different apparatus, was put up at the late Exhibition at Kensington, but, owing to an accident, it was not completed till too late for its effectiveness to be shown; the Exhibition in fact was half over before it could be got into condition, and its presence, in the earlier months, full only of dirty water, was prejudicial rather than otherwise to an interesting pursuit. The Society for Acclimatization of Animals in France have now an aquarium of the same method of construction and arrangement, or nearly the same, at their gardens in the Bois de Boulogne, and which has more compartments to provide for the separation of animals; but similar attempts in this country to obtain a successful result with unchanged sea water, are in the hands of amateurs, and that which forms the subject of this paper was one of the earliest, preceding even the one at Paris.

The aquarium now to be described is 9 feet long in front, 4 feet 3 inches wide from front to back, and 27 inches deep, and contains when full 400 gallons of sea water, divided into three compartments of equal size, each therefore holding about 133 gallons. This large tank is constructed of strong slabs of slate, viz., one for the bottom, and one for each of the sides, and back, and for the divisions into compartments, while the front only is of glass, of three stout squares of plate, firmly cemented into grooves cut in the slate slabs and into a bar of slate that goes over the top. The facings of the slate work are moulded, and their surfaces planed and rubbed smooth, so that it can be decorated by paint and gilding, and thus rendered ornamental if desired. Inside the divisions, slabs of slate are reared from the bottom, at one-third the distance from the front, sloping upwards to the back, and reaching to within about six inches of the surface of the water when the tank is full. The rockwork is built on this sloping shelf, and up the sides of the compartments. In front of the shelves the bottom of the tank is covered by two or three inches of fine sand, with a rock here and there, and shells, and so forth. There is thus presented to the view of a person looking in through the glass front, an imitation on a small scale, of a shelving rocky shore, very convenient for a view of all the creatures affixed to or roaming about thereon. We might indeed suppose one of the little tide-pools of the sea-shore to have been cut in two, and the half of it to have been raised to the level of the beholder's eye. The angular space behind the sloping bank is a dark water chamber, the water passing in and out, when any motion is given to the fluid in the aquarium.

Those readers who are acquainted with what has been done in aquaria during the last four or five years, will recognize in the above description "a patent slope-back tank with dark water chamber" on a large scale; but it was necessary to describe the arrangement, as all may not have seen that form of tank, which has its special advantages over every other yet devised, as will be explained later on. To such as have seen these tanks only on a small scale, the comparison with the half of a tide-pool of the sea-shore will perhaps be deemed imaginative; but let them consider the advantage which the size of the tank described gives for the arrangement of the rockwork, how much better an effect can be produced by the use of bolder masses, by making rugged sides, by forming miniature caves, by the tumbled-down appearance that can be introduced here and there, and by little indented bays with small sand ridges which the tide has washed—all of which can be accomplished with sufficient space, as in the one described, but is not quite practicable in a wash-hand basin aquarium. Added to these advantages, if a good and varied coloured vegetation can be induced to grow, and living creatures preserved in health, an artificial section of a tide-pool will perhaps approach the reality of a natural scene.

Before proceeding further, it is well to make some slight allusion to previous attempts by the same owner with aquaria of smaller size. Three will be sufficient to refer to, viz., a small vase for one; another, a double cube, 3 feet, 18 inches by 18 inches, all glass sides, and thirdly, a patent slope-back dark water-chamber tank, of about 33 inches square, 16 inches deep, holding 60 gallons, or thereabouts. The cube was found a very objectionable form; in vases, according to slope and depth, some limited amount of success may be obtained—when the depth is only about a third or fourth of the diameter it is best; but it was the results obtained with the third form that led to the construction of the larger tank. That third vessel was placed close to a large window facing the north, in which situation, by a little attention to shading in summer when the light is strong, the water is kept clear with the greatest ease, provided that decaying animal substances are not allowed to accumulate. If a small number of animals, say only ten individuals, of appreciable size, were kept in such a sixty-gallon tank, it is probable that, with a little feeding now and then, they might survive with tolerable comfort; but it was found that such a stock as most people would wish to see in an aquarium of such dimensions could not be satisfactorily maintained. It should be considered satisfactory when the creatures live to the full term of their natural life in proper size and beauty, but not so when they gradually

dwindle away, as anemones in confinement usually do. They dwindled in the said aquarium, notwithstanding every effort was made to feed them sufficiently. They gradually lost the power of taking food when offered, and the conclusion was inevitable, that an aquarium with stagnant water, however well aeration might be performed by oxygen derived from growing vegetation, and by absorption from atmosphere at the surface, did not supply such conditions as suited sea anemones, and that those only could be satisfied with such an aquarium who did not mind seeing their creatures dwindle away, renewing them with fresh specimens from the sea, to die away in like manner in turn.

Some experiments were then made in the same tank with a view of seeing if a better arrangement could not be adopted. The old practice of syringing the water, beneficial to some extent, is not convenient, yet motion of some kind seemed wanting, as the sea is always in motion. Moreover, when syringing was tried, it did not seem to be thoroughly to the taste of the creatures. A better kind of motion was that caused by a pair of flexible wooden nippers, the blades of which should be about an inch asunder, held in the hand perpendicularly in the water, in one corner of the tank, dipping from one-third to one-half the water's depth. A motion being given to these by action from the wrist only, they are made to perform a cone-like revolution in the water, and by a little additional impulse applied when at one part of the turn, and three strong strokes, followed by three lighter, and then a pause, three waves are driven round the tank, on the top of a good current, much felt in the shallower water, but also more gently in the deeper. The current will gradually cease as the motion of the nippers or spindles becomes slower, and stops, but will be followed by a rippling, which will last a little while. Before it has subsided, the action of the hand should be resumed, in an opposite direction, so as to reverse the course of the current, and so on alternately. So good an effect will not be produced by a single stick as by the double spindle, because, with the latter, more air is carried down, and dispersed in minute bubbles throughout the tank, and it seems to make the current and wave better. By such motion a very efficient aeration is caused, all the water being continually brought to the surface, and in contact with the atmosphere. It was subsequent experiment that proved the full value of this kind of motion, but at the time of first trying it, the necessity of agitation of some kind or other was made apparent, for anemones which had been long confined, and were rarely expanded before, gradually opened under its influence, and after two or three days' perseverance in it, for half-an-hour or so twice each day, those

anemones which, even when casually expanded, would not take food before, retained and swallowed eagerly any morsel that was dropped into the current so as to come within reach of their tentacles. Such anemones also began in a very few days to show signs of improved condition. The effect then was seen to be beneficial, but the operation was liable to one of the same objections as the use of the syringe, namely, that it had to be performed by hand, thus requiring time and regularity, and therefore not always convenient to be done. Various projects were considered for getting over this difficulty, and it appeared that if something like the fan of a screw steamer could be got to work for a few hours each day, or better, continuously, by some simple kind of inexpensive and not bulky machinery, it would do; but the representations of others, that it was impracticable, deterred any further attempts in that line for the time,—and possibly for small aquaria it could not be accomplished at a sufficiently cheap cost to make it worth while, but for large tanks, such as public museums or zoological gardens should have, there is nothing impracticable in it.

Besides this question of moving water, others forced themselves into notice. Principally, that tanks must be very much enlarged, or the number and variety of creatures kept in one single aquarium much reduced. Anemones, if expected to show beautifully, ought not to be crawled over every ten minutes by a crab, nor a prawn compelled to make half-a-dozen attempts before he could settle down clear of an anemone, and so escape its nettling threads. It was pitiful to see the tails of mullet half nibbled away by sticklebacks, and evident that in a tank stocked with all these, the multiplication of those small creatures, the entomostraca and infusoria, on which some of the sedentary animals chiefly subsist, was a complete impossibility, for the active swimmers almost exterminated them. Thus there was positively no natural food for any kind of creature excepting those which live upon vegetation and vegetable spores, but all else became entirely dependent upon being fed by hand. Not only, therefore, the enlargement of tanks, but also the separation of creatures whose habits were very distinct from one another, seemed a point to be desired; and, if added to this, some control over excess of temperature could be had, one could not understand why creatures within reasonable limits as to number and size should not be successfully kept. Perpendicular light, instead of the side-light of a window, was also thought about, as the most natural, and therefore likely to be generally the best, both for animal and vegetable life. When shade was wanted, it could be arranged for by projecting pieces of rock, and other devices.

It was in the years 1858 and 1859 that the experiments

and observations recorded above were made, and in the latter year the large tank with three compartments, as first described, was determined upon. It was made tidal as follows, if the expression, "tidal," is not too grand:—

A cistern was constructed underground, of brick, lined with Portland cement, and, before covered in, tested, and ascertained to be perfectly watertight. In it, at one corner, is fixed a filterer—a slate vessel, filled with sand and shingle, alternate layers, and larger pebbles at top. This filtering medium, of sand and shingle, does not rest on the bottom of the slate vessel, but on a slab of the same material, perforated all over with small holes, drilled regularly through. This slab is fixed in the filterer so as to leave a space of about two inches from the bottom, to allow of water to pass into it freely from the aquarium, and to rise through the perforated slab and filtering mass, then to trickle over the top of the filterer into the cistern. The latter was then made secure, and covered over at such a depth under the soil that neither heat nor frost could exercise much influence on its contents.

Close beside this cistern, but not over it, the building was erected for the aquarium itself. It was placed against the north end of a dwelling-house, and formed like an attached greenhouse, but with walls of brick; the roof being of glass, and one window looking northwards, towards which quarter also the roof shelved; there was no other illumination but from the window and roof. The aquarium was put up on firm supports in this building with its glass fronts inwards, that is, towards the house, sufficient space for spectators to sit at and to pass all round the tank being provided. The inside of the wall is coloured a neutral tint, and a portion of the glass roof painted black, namely, that part over the space between the fronts of the tank and the house-wall, and a little more. Slate covers also were provided for the top of the deeper part of the tank, extending over about one-third of its width, and giving a partial shade beyond. The effect of this arrangement is, that the spectator himself is out of direct illumination, as also is the front part of the tank, while the light falls strongly on the surface of the shallower water at the back, and zones of various shades of light extend from thence to the deeper water. The light falling on the glass fronts is so very modified in power that vegetation scarcely grows upon them. A slight sponging every month or two, according to season, keeps them perfectly clean, so that a bright view through them into the interior of the aquarium is a matter of no difficulty. The zones of light are adapted to the requirements of a varied vegetation, whilst both plants and animals are brought out better, as they stand in relief against the back light, as we see any object on a hill against the sky.

A third cistern is placed outside, at a considerably higher level, in the open air, in an angle formed by the walls of the house, in a situation sheltered from the sun.

In each compartment of the aquarium there are siphons with stop-cocks below, all leading into a main pipe that takes the water into the lower cistern through the filterer. From thence it is pumped up to the upper cistern last mentioned, and allowed to flow back into the aquarium through fine jets; or water can be forced from the lower cistern direct into the aquarium itself. There are stop-cocks to check the flow in or out of any compartment; but it is not intended to describe this apparatus particularly, afterthought having suggested other efficient and much less expensive plans of producing the same effect. All at present needful is to show that the water can be let out of the aquarium either wholly or in part to any depth required, and forced back again from the upper cistern or from below direct. If from above, the force of the jet will depend upon its size, and the height at which the upper cistern is situated, and thus the amount of stream or aeration in the aquarium, and the time it occupied in refilling it, can be adjusted at will. Let us suppose that the water has been permitted to run out of the aquarium, and leave the upper stones and anemones on them dry, as on the sea-shore when the tide is out.

The length of time of their exposure to the air is regulated by the strength of the jets and the turning of the stop-cocks, and it may be done once or twice daily, or only when thought needful. Before returning, the water has been filtered and cooled in the lower cistern, and the jet impinging upon the surface of the remaining water in the tank, at a certain angle, drives down with it an immense quantity of air, which becomes dispersed throughout the tank in minute bubbles. A very fine jet is sufficient to create a stream of water and air in every part of the tank, and the stream can be kept continuously running in one or all the compartments if desired, there being overflow pipes to carry the surplus water back again below, when the aquarium itself is full after giving tide. For this purpose a little more water was supplied than necessary to fill the aquarium, and which surplus water remains ready for use in the lower or upper cistern when the jets are not running. The above can be made so self-acting in any suitable situation as to require only very little personal attendance daily.

To sum up the whole, the means are provided in this aquarium for exposing the creatures and vegetation to the action of the atmosphere, as on the sea-shore, during which exposure any noxious gases escape freely, and a purification of the tank is effected. There is also a continuous movement, a change and aeration of the *same water*, which may be used over and

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over again; a control over excessive ranges of temperature; provision for perpendicular light, and for a beneficial regulation of the amount of it.*

COMETS.

AN ACCOUNT OF ALL THE COMETS WHOSE ORBITS HAVE NOT BEEN CALCULATED.

BY G. CHAMBERS.

(*Continued from page* 101.)

107. On September 13, a strange star appeared to the S.W. of δ and ϵ Canis Majoris.—(Hind.)

108. On July 25, a comet appeared in Ursa Major, with a tail 2° long, which extended in a S.W. direction toward κ and ι of that constellation.—(Hind.)

110. In January, a comet rose to the S.W. of γ and ζ Eridani. It had a bluish tail 6° or 7° long, pointing to the N.E., in which direction it moved.—(Ma-tuoan-lin.)

115. On November 16, an extraordinary star appeared in the west. On November 21 it was to the S. of β and α Aquarii, and afterwards moved to Musca and the Pleiades.—(Gaubil refers this comet to 117.)

123. In December, a strange star was seen in the region near α Herculis and α Ophiuchi.—(Hind.)

132. On January 29, a strange star, with a tail 2° long, pointing towards the S.W. was observed. Its R. A. was 6° greater than that of β Capricorni; it was also seen near δ Sagittarii, and moved near β Aquarii, α Equulei, and α Aquarii, towards ϵ and θ Pegasi.—(Ma-tuoan-lin.) This comet was seen in Europe in the time of Adrian, whose courtiers told him that the soul of Antinoüs had been changed into a new star.—(Dion Cass. lxix.)

133. On February 8 an extraordinary star, with a vapour 50° long and 2° broad was seen to the S.W. of γ Eridani.—(Hind.)

149. On October 19, a comet, with a tail 5° long, was observed in head of Hercules; it was only seen for four days.—(De Mailla, iii. 441.) Gaubil says that it appeared in 148, and Ma-tuoan-lin, in 147.

* It should be known that the magnificent aquarium described by a contributor in the preceding pages is the property of Frederick Drabble, Esq., of Llandudno, N. Wales, and having had frequent opportunities of visiting it in September, 1862, we can bear testimony to the unusually fine condition of its living inhabitants, and to the kindness and courtesy of their owner, whose devotion to marine zoology has been rewarded by signal success.—Ed. I. O.

161 (i.) In February or March a comet was seen near *a* Scorpii.—(De Mailla, iii. 459.)

161 (ii.) On June 14, an extraordinary star appeared in the R. A. of *a* Pegasi. It remained stationary for some time, and then retrograded, and when it had reached the R. A. of 14h. it threw out a tail 5° long.—(Ma-tuoan-lin.)

180 (i.) In August or September a comet was discovered near *ν* and *ξ* Ursæ Majoris. It moved eastward to the tail of Leo, and disappeared in three weeks.—(Ma-tuoan-lin.)

180 (ii.) Another comet was visible in 180 for two or three months in the winter. It came from the E. of Sirius, and moved to *υ* Hydra, where it vanished.—(De Mailla, iii. 506; Ma-tuoan-lin.)

182 (i.) In February, March, or April, a comet was seen near *δ* Andromeda. It tended towards the E., entered the circle of perpetual apparition, but left it again after three days. It was visible for nearly nine weeks.—(Ma-tuoan-lin.)

182 (ii.) In August or September, a comet appeared near *ι* and *κ* Ursæ Majoris, which was also seen in the vicinity of *β* Leonis.—(De Mailla, iii. 507; Ma-tuoan-lin.)

188. A comet was observed in March or April.—(De Mailla, iii. 520.)

190±. During the reign of Commodus, a hairy star was seen.—(Ælius Lampridius; Herodian, *Hist.* i.) No more exact date is assignable.

192. In September or October, or perhaps a little later, a grand comet 100° long was seen to the S. of *a* Virginis.—(Ma-tuoan-lin.)

193. In November, a comet was seen near *a* and *ζ* Virginis, moving towards the N.E.; it arrived in the region near *a* Hercules and *a* Ophiuchi it disappeared.—(Ma-tuoan-lin; De Mailla, iii. 563.)

200. On November 6, a comet was observed near *δ* Serpentis.—(De Mailla, iv. 35; Ma-tuoan-lin.)

204. In November or December, a comet appeared in Gemini, which passed by *δ* Cancri to near *β* Leonis.—(De Mailla, iv. 40; Ma-tuoan-lin; Dion Cass. lxxv. 16.)

206. In February a comet was observed in the square of Ursa Major; the tail extended over the whole of the circle of perpetual apparition; it reached to Ursa Minor.—(De Mailla, iv. 43; Ma-tuoan-lin.)

207. On November 10 a comet appeared in Leo.—(Ma-tuoan-lin; Couplet.) De Mailla assigns this comet to the previous year.—(*Hist. Gén.* iv. 45.)

213. In January a comet appeared near *θ* and *υ* Geminorum.—(De Mailla, iv. 63.)

222. On November 10 a new star was observed between

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β Virginis and σ Leonis.—(Gaubil.) It is uncertain whether this was a comet or a temporary star.

225. On December 9 a comet was discovered near m Leonis; it traversed the head of Leo.—(Ma-tuoan-lin.)

232. On December 4 a comet was seen near σ Leonis. It approached β Leonis.—(Ma-tuoan-lin.)

236 (i.) On November 30 a comet, with a tail 3° long, was seen near α Scorpii; on December 1, it (or another comet) was seen in the E.—(Ma-tuoan-lin; Gaubil.)

236 (ii.) On December 15 a comet was seen between θ and ζ Herculis.—(Ma-tuoan-lin; Gaubil).

238 (i.) In September a comet with a tail 3° long was observed in Hydra and Crater: it moved eastwards and disappeared in six weeks.—(Gaubil; Ma-tuoan-lin.)

238 (ii.) An extraordinary star was visible from November 29 to December 15. It moved from α Aquarii through the north of Pegasus, by Cygnus, and the W. of Aquila, to near γ Ophiuchi. —(Ma-tuoan-lin.)

245. On September 18 a comet with a tail 2° long appeared near α Hydræ: it moved towards Crater, and remained visible for three weeks.—(Gaubil; Ma-tuoan-lin.)

247. On January 16 a comet with a tail 1° long was observed; it had the same R. A. as Corvus, and was visible for eight weeks.—(Ma-tuoan-lin.)

248 (i.) In April a comet was seen in the Pleiades. Its tail was 6° long and extended towards the S.W.—(Ma-tuoan-lin.)

248 (ii.) In August a comet appeared having the same R. A. as Crater; but which gradually increased. The tail was 2° long, and it remained visible for six weeks.—(Ma-tuoan-lin.) Pingré (from Gaubil) says it was in the *constellation* Crater, and not in the *sidereal division* of Crater, as Hind gives it.

251. On December 21 a comet appeared between α and β Pegasi. It moved westwards, and disappeared after thirteen weeks.—(Ma-tuoan-lin.)

252. On March 25 a comet was observed in Musca, with a tail 50° or 60°, stretching towards the S. It afterwards passed between the bright stars of Orion, and was seen for three weeks. —(Gaubil; Ma-tuoan-lin.)

253. In December a comet appeared near γ Virginis. The tail pointed to the S.W., and was 50° long. It remained visible six months.—(Ma-tuoan-lin.) Hind remarks that probably the comet's motion was retrograde, and therefore it receded from the sun's place towards the W.

254. In December a vapour emerged from near δ Sagittarii. Its length is stated to have been very great.—(Ma-tuoan-lin.) Pingré doubts whether this was a comet or not.

255. In January or February a comet was observed in the N.W. near the horizon.—(Ma-tuoan-lin.)

257. In November or December a white comet was seen near *α* Virginis.—(Ma-tuoan-lin.)

259. In November or December an extraordinary star was seen near *β* Leonis. It moved towards the S.W. and disappeared in a week.

262. On December 2 a comet with a tail 50° long appeared near *κ* Virginis. It moved towards the N. and was visible for six weeks.—(Gaubil.) Ma-tuoan-lin says it had only a tail five tsun long, whatever that may mean.

265. In June a comet was seen near *α* and *β* Cassiopeiæ. Its tail was 10° long and pointed to the S.E., and after twelve days it disappeared.—(Ma-tuoan-lin.)

268. On February 18 a comet was seen in Corvus. It advanced to the N.W., and subsequently turned towards the E. (Ma-tuoan-lin), which remark probably has reference only to the tail (Hind).

269. In October or November a comet was seen within the circle of perpetual apparition.—(De Mailla, iv. 148.)

275. In January or February a comet was discovered in Corvus.—(Ma-tuoan-lin.)

276. A comet was visible from June 23 to September. It moved from near *α* Libræ, by *α* Boötis to *β* Leonis, and attained to *χ* Hydræ, the square of Ursa Major and Ursa Minor.—(Ma-tuoan-lin.) Hind suggests that in place of reading the group of *χ* Hydræ we should read the sidereal division of *χ* Hydræ, in which case the several positions may fairly be considered as applying to the motion of the head and the direction of the tail of one comet, though Ma-tuoan-lin states there were three.

277 (i.) Ma-tuoan-lin says that in January or February there was a comet in the W., and in April or May, another in Musca, which two are probably identical.—(Hind.)

277 (ii.) Ma-tuoan-lin says that there was a comet in May or June, near *π* Leonis, and another in June or July in the W., whilst De Mailla (i. 162) speaks of a third within the circle of perpetual apparition in August or September. Hind thinks that these three are one.

278. In May a very large comet appeared in Gemini. It lasted eight months (?)—(Ma-tuoan-lin; Gaubil.)

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PLÜCKER'S RESEARCHES IN ELECTRICITY.

BY ALEXANDER S. HERSCHEL, B.A.

THE able investigations of Professor Plücker, of Bonn, on the discharge of electricity of tension through rarefied gases, continue to add new revelations and fresh confirmations to our acquaintance with the operations of this subtle and powerful agent. It is now a quarter of a century since Professor Faraday, in his original researches, developed the theory of the molecular character of every transfer of electrical activity from place to place. From the induced excitations of Franklin's doubly-coated plates of glass, to the evolution of chemical elements at the immersed poles of a galvanic circuit in a fluid, all permanent and fugitive electrical affections were rightly ascribed by him to carrying powers residing in the ultimate molecules of interposing substance. The same theory receives new illustrations in the experiments detailed by Dr. Plücker. The well-known Ruhmkorff coil is the powerful electro-motive source of the new effects. On the principle of the Neaf's hammer and Bull's battery of our medical electricians, a primary current in this instrument, enveloping a core of iron, produces, by automaton interruptions and restitutions of its own passage, rapid and powerful pulsations of electricity in a secondary coil of wire collateral with the former throughout their common length. To comprehend the origin of these pulsations, we return to the mutual influences, one upon another, of a galvanic current and a magnet, first discovered by Oersted, extended by his successors, Ampére, Arago, and others, and ably investigated by Faraday.

It is a well-known fact that the northerly point of a mariner's needle will be driven from the front towards the right of a descending current of electricity; or if fixed, will cause the current and the conductor, if free, to shift to their left; so that, if permitted, the latter would circulate continuously with the hands of a watch about the summit of the needle. Professor Faraday, however, showed that the mere motion alone, of the kind indicated, either on the part of the needle or of the conductor, is sufficient to cause in the latter an *as*cending current of electricity. Such a reverse current opposing the primary current, where motion of the needle or of the conductor is permitted, occasions in it a loss of power proportional to the effect produced. Transportable currents may thus become enfeebled in the presence of a powerful magnet in proportion to their mobility; and it is highly probable that the vacillatory appearances observed in Mr. Plücker's vacuum discharges, when, by suddenly exciting a powerful electro-magnet,

the current is thrown from one side to the other of the tube, may offer in this view, as will afterwards appear more fully, a complete illustration of the fitful and mobile beams of the Aurora. Sudden motions of the magnetic poles in the collateral wire, and especially in the iron core or centre of the coil, on the first passage of a galvanic current through the primary wire, may be employed to account for the reverse current which then for the instant appears in the collateral or secondary wire; while the sudden return of the poles to their original arrangement on cessation of the primary current would generate a similar impulsive current through the same coil, in the opposite or primary direction. Of the condition assumed by the secondary wire *during* the passage of the primary current, known after Dr. Faraday as the "electrotonic" state, no appliances have hitherto detected evidences beyond the two different currents that attend the moments of its assumption and dismissal. Unlike the currents which circulate in a coil on moving it near a magnet, or on heating the place of contact of two dissimilar metals, these characteristic currents are impulsive and momentary. It was discovered by Mr. Ruhmkorff that connection of the two wires of the main or primary coil, near the battery, with the inner and outer coatings of a Leyden jar, or with the two opposed plates of an extensive condenser, greatly exalted the effects. Free electricity accumulates abundantly upon the plates from the voltaic pile before the contact is renewed, thus enabling a stout wire of few convolutions to produce suddenly a high degree of magnetization, while in Mr. Ruhmkorff's construction an extensive coil of fine wire is made to absorb nearly the whole of the reaction of the iron. From the freedom with which electricity traverses metallic conductors, a great accumulation and high tension is occasioned at the extremities of the induction coil. Vivid sparks approaching to an inch in length may be drawn between them; but it is evident that if not so relieved, the tension on cessation of the impulse will neutralize itself by return within the wire, and be succeeded by tension of the opposite character on the following pulsation of the coil. Glass plates of one-eighth of an inch thick and upwards may be perforated by the tension, heightened by proximity, of the terminal wires.

If single metallic coatings upon two plates of glass be connected with the termini in such a manner that the plates of glass may oppose each other at a distance of an inch or more, sparks pass between their faces on arrival of the current. The same occurs in all the intervals of air, when the terminal wires are withdrawn a short distance from the outer metal sheets. The complete explanation of these sparks, first noticed by M.

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Dumoncel, is due to the labours of Mr. Gassiot and Dr. Plücker, and with the new ingenious modifications of Geissler's vacuum tubes they become the most beautiful illustrations of Professor Faraday's theory of induction.

If the terminals of a Ruhmkorff coil be inserted in two separate exhausted tubes of air or other gas, and the coil be excited, brush discharges emerging from the wires extend almost to the boundaries of the vacuum cells. These are wonderfully intensified by partly covering the exteriors of the cells with tinfoil, and effecting metallic communication between the coats. But, again, the same effect will be produced if, in place of a distant metallic communication, the cells are closely applied to one another, by dividing a single tube into two cells with an inserted diaphragm of glass. A third cell may be interposed between them, by employing two diaphragms of glass; and will then appear to act like the metal, causing no diminution of brilliance in the terminal spaces, but itself glowing with a similar discharge. Numerous cells may be inserted, containing different gases at pleasure, and all exhibit the discharge with equal brilliance. The experiment is, then, a modified form of that of M. Dumoncel, exhausted air being used in the place of air of ordinary density, and luminous currents appearing in the place of sparks. The singular character of these discharges has been investigated successfully by Mr. Gassiot and Dr. Plücker by the use of the magnet. The exhausted air in the neighbourhood of the terminal wires, thrown into a highly inductive state, yields to the tension, and passes onward the electricity by a luminous current to the farthest boundaries of its substance. The glass diaphragm becomes inductively polarized, and the natural electricities of the succeeding gaseous space are divided, part being determined to one, and a part to the other end of the cell, with luminous effects. The same induction and division of electricities takes place in the next diaphragm and cell, until, in an instant, the equilibrium of induction is established between the two terminal wires of the coil. On the subsidence of the impulse inductive polarity disappears, and the natural electricities in the gaseous spaces re-unite with contrary currents to those before exhibited. The returning luminous current, although succeeding the first at an insensible interval of time, is made separately visible to the eye by the use of a magnet, which compels opposite currents to follow opposite sides of the internal tubular spaces of the cells. The successive compartments of the compound tube enclose, under ordinary circumstances, volumes of highly and variously-coloured light; but under the action of the magnet, loops of light, lining the interiors, are seen at each pulsation of the coil. If a cell be drawn at the centre

into a capillary tube, the branches of the loop will neither coalesce nor cross, but may still be traced at this point by a magnifying lens in the form of two brilliant lines most deli-

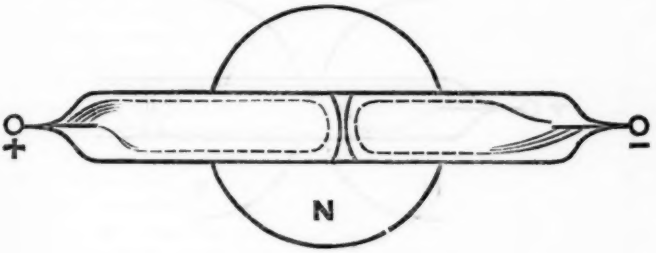


FIG. 1.

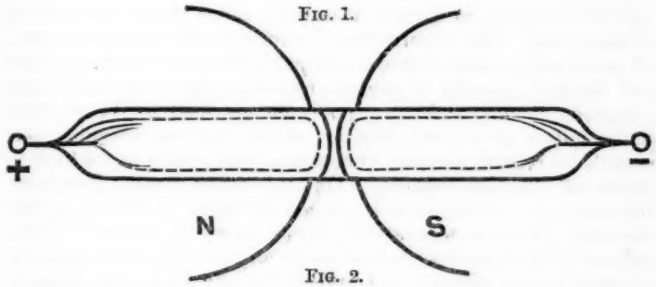


FIG. 2.

cately divided. We here perceive occularly that division and re-union of natural electricities which Dr. Faraday supposed to occur in each isolated particle of a dielectric medium, when such a medium is subjected for a moment to inductive polarization between the excited faces of two oppositely electrified bodies.

It is only when made to cross at the centre of a cell by drawing the halves of the cell over opposite poles of a magnet (see fig. 3) that Dr. Plücker has observed vacillatory effects of the kind before mentioned in the transported current, but momentary suspensions of a current by a magnet, accompanied by sonorous tones, have since been obtained by Mr. Gassiot in certain very similar experiments. Experiments were undertaken to ascertain the degree of exhaustion at which electrical discharge in rarefied air ceases to be luminous and visible. It was observed that disruptive discharge by spark became converted gradually into an envelope of the spark, or diffuse stream, as the exhaustion advanced, and that the stream decreased to a line of very feeble light at one-eighth of an inch

of barometric pressure. This finally disappeared at half a line of pressure of the same standard. The latter degree of exhaustion corresponds, according to the best tables of atmo-

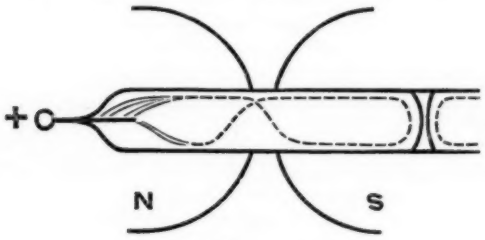


Fig 3.

spheric pressure, to forty-five English miles above the surface of the earth. The occurrence of auroral arches and streamers, of admitted greater altitude, and particularly of shooting stars and fireballs, equally of greater elevation than the limit here assigned, cannot, therefore, justly be ascribed to an electric cause, unless great irregularities of surface and singular upheavals be regarded as not uncommon occurrences in the higher strata of the atmosphere. On the other hand, Professor Plücker draws attention to a marked character of aërial electric currents. In air comparatively dense they obey all the solicitations of the magnet; but in rarer air, or gas, that path is selected by the current least subject to magnetic disturbance, and discharge takes place accurately along the curves of force, emanating from the pole and passing through the point of emergence, for the moment, of the luminous current from the wire. In this particular, such currents closely imitate the appearances common in auroral beams which, springing from all parts of the horizon, constantly appear to converge in a crown or ring to that point near the zenith of the heavens towards which the south pole of a magnetic needle itself directs when the northern pole is free to dip, in obedience to the magnetism of the earth. It thus appears highly probable that the mobility and intermittences in the lower flashes of an aurora, accompanied by vertical propagations of light in the highest branches and streams, will ultimately receive a complete explanation in the combined electrical and magnetical activities of the earth. That a similar explanation will be established for fireballs and shooting stars appears more doubtful.

THE MOTIONS OF CAMPHOR.*

A CHEAP little book has just appeared which suggests scores of interesting observations, that require no expensive apparatus, or unusual skill to perform; we allude to the *Experimental Essays* of Mr. Charles Tomlinson, one on "the Motions of Camphor in Water," the other "the Motion of Camphor towards Light," and the third on the "History of the Modern Theory of Dew." All three are compactly published in one small volume, but it is of the two former only that we now speak. Every one knows that if a piece of camphor is thrown into a clean vessel holding clean water, it commences a series of remarkable movements, which continue for a considerable time. This curious phenomenon has long attracted the attention of scientific men. Mr. Tomlinson's papers give a succinct account of their labours, and of the various theories from time to time put forth. The real explanation seems to be that which he suggests, namely, that "the adhesion of the surface (of the water) constantly detaches from the fragment (of camphor) a portion of its substance, and spreads it out in a film, which film reacting on the fragment, produces reaction after the manner of a Barker's Mill." The Barker's Mill is a contrivance by which an arm mounted upon a pivot rotates, if currents of water or steam move in opposite directions from either end. For the satisfactory exhibition of the camphor motions, it is necessary that the camphor films should be got rid of quickly. This is partly effected by their solution in the water, but still more by their evaporation, and hence a fine warm day, when the latter process goes on quickly, is most favourable.

Among the great variety of experiments detailed by Mr. Tomlinson to make the camphor currents conspicuous, he obtained excellent results by powdering the surface of the water with a layer of lycopodium, and then throwing in the midst of it a little bit of camphor. "The very moment," he tells us, "the camphor touches the water, there is a strong repulsion of the lycopodium, and a clear circular space of water is opened a couple of inches in diameter. Then there is a pause for a moment, when all at once the lycopodium is formed into a number of revolving wheels, arranged in pairs, the two members of each pair revolving in opposite directions, the whole forming a wonderfully beautiful and striking figure." He further tells us that "the number of wheels in a glass four inches in diameter may

* *Experimental Essays*, by Charles Tomlinson, Lecturer on Physical Science, King's College, London. Virtue Brothers and Co.

be four, six, eight, or ten, according to the size and shape of the piece of camphor, and the vigour with which the process is carried on."

Another interesting series of experiments may be made by dissolving camphor in benzole, and throwing a drop of the solution on the surface of perfectly clean water. The drop forms a lens-like body, which, after various antics and motions, splits up into smaller discs, which go through strange contortions, and at last leave a crystalline film of camphor on the water surface.

This last observation may be agreeably varied by the employment of the microscope. The following is the plan we have adopted for this purpose. Take a hollow glass slide* and make it chemically clean, by washing it with a drop or two of hartshorn if grease is suspected, and then rinsing in clean water and wiping it with a perfectly clean cloth. The small cup-like depression in these slides forms an excellent vessel for our purpose. Let one be filled with clean water, which may be taken up for the purpose with the dipping tube. Then bring the microscope body to a *vertical* position, so that the stage is horizontal, and the water has no disposition to run out when the hollow slide is placed upon it. Matters being thus arranged, put a two-inch power on the microscope, and bring the surface of the water into focus, and while looking through the instrument put a minute drop of the camphor solution—prepared as directed below—on the water in the centre of the field. A great commotion will be immediately seen. On the edges of the drop of camphor solution, which will look large under magnification, minute drops will form, exhibiting curious curvilinear motions. Some will dart off, and whirl round and round, during which process spots of crystallized camphor will appear, grow bigger, and finally spread into a film which may be quiet, or put forth prolongations and undergo contortions before repose comes on. Some drops will take amœboid or protean forms, others again will develop long crystalline threads, spreading in various directions, but the end will be the production of a film of crystallized camphor, often assuming exquisite arborescent forms.

The solution may be made by putting a piece of camphor as big as a pea into a two-dram phial, with one dram of *benzine*, now sold by all chemists to clean ladies' gloves. A pin should be thrust into the cork of the phial with the head downwards, to which enough of the solution will adhere when the cork is taken out. It is then only necessary to touch the surface of the water for an instant with the head of the pin, taking

* The so-called hollow slide can be had of all microscopic opticians. It is a plate-glass slide with a rounded depression in the middle.

care not to convey too much. If the solution is of the right strength, the appearances above noted will be seen, or something like them, for they vary each time. If too strong, the film of crystalline camphor will form too quickly, and then a little more benzine may be added. If too weak, the motions will be inconspicuous, and then a little bit more camphor may be dropped in. The observer should particularly notice the changes in the fluid level which the camphor films and currents will produce. The addition of a second or third drop from the pin head will vary the effects.

Mr. Tomlinson's researches lead him to deny the accuracy of the explanations usually given of the formation of camphor crystals in bottles exposed to light. He says, "a bottle of camphor in the dark produces no deposit, even after months of exposure, but when put in a window a deposit forms immediately. One bottle put within another forms no deposit, even though exposed to the diffused light of day. Exactly so. A bottle shut up in the dark is protected from radiation; it is equally warm all round, and though filled with vapour, there is no sufficient reason why a deposit should be made at one part of the bottle more than another. Put that bottle in the window, and it becomes cooled on the side nearest the window pane, and a deposit is made. Light has nothing to do with this result." He adds that he has taken a bottle of camphor out of a cupboard, and obtained a deposit in three minutes by exposing it in a window when the moon was shining. This looks, at first sight, like a confirmation of the light theory, but the same result was obtained when there was no moon.

We must refer to Mr. Tomlinson's book for the details of scores of experiments made with various materials, and in divers ways; but we must quote his opinion on the storm-glass, because he does not seem by any means to have exhausted the curious subject of its indications. He remarks, "as a weather indicator it does not appear to be of much value; it rather follows the weather than precedes it, and seems to depend for its action entirely upon variations in temperature." Admiral Fitzroy, who has been trying experiments with these glasses since 1825, says that nothing could be made of their variations until lately, but that it is now ascertained that if they are fixed undisturbed in free air, out of the way of radiation from fire or sun, the appearances vary in character with the direction of the wind, and with electrical tension. He tells us, as the atmospheric current veers toward, comes from, or is only approaching from the polar direction, this chemical mixture "if closely, even microscopically watched, is found to grow like fir, yew, fern leaves, or hoar frost, or like crystallizations."

As the wind comes, or tends from the opposite quarter, the

regular, hard, and crisp features vanish. Before, or during southerly wind, the mixture sinks and becomes shapeless. Stars indicate easterly winds, produced by a combination of the main currents, while an opposite combination, making west winds, is indicated by clear, liquid, and well-defined crystallizations. Crisp features indicate *plus* electricity in the air; a melting sugary appearance, *minus* electricity. "Temperature," adds the admiral, "affects the mixture much, but not solely, as many comparisons of winter with summer changes of temperature have fully demonstrated."

We have satisfied ourselves that the ordinary directions sold by opticians with storm-glasses are worthless, and we incline from our own observations to think that Admiral Fitzroy is right. The subject is well worth elaborate investigation, and Mr. Tomlinson gives the following formula, the quantities mentioned filling * a larger glass than is usually made :—

Camphor . .	2½	drams.
Nitre . .	38	grains.
Sal ammoniac .	38	,,
Water . .	9	drams.
Rectified spirit .	11	,,

Camphor crystallizations from this solution, or in dry bottles, do not seem to depend upon changes of temperature *only*. The rate at which they take place and the partial manner in which they affect the tubes or bottles, is evidently important, and the electrical state of the air may have its influence as Admiral Fitzroy states, or the result may take place from the alterations in temperature that usually accompany electrical changes, without the latter having any influence in the matter.

The ordinary storm-glasses, covered with a brass cap, may not be quite air-tight. It seems advisable to make some which are hermetically sealed, and others which are closed in the usual way, to see if changes in atmospheric pressure exert any power over the behaviour of their contents.

Mr. Tomlinson says, with reference to the camphor crystals in dry bottles, "the conditions required for the production of fine deposits are warmth to raise the vapour, and cold on one side to condense it." If this be so, it would seem that the bottles under ordinary circumstances only contain enough camphor vapour to supply one side with fine crystals; but if they were made warmer so as to increase the evaporation of the camphor, both sides ought to yield fine crystals, if cooled with the right degree of slowness or rapidity, and to the requisite extent. We do not quite understand what Mr. Tomlinson means by stating as an explanation of why he did not obtain deposits in certain cases, that "a thick glass tube, by exposure to the light, does

* About three-quarters full is sufficient.

not cool unequally, but slowly varies in temperature throughout its mass, so that no deposit either of mercury or of camphor is possible." The unequal cooling can only determine the unequal deposit of the condensed vapour. Equal cooling would cause an equal deposit, if sufficient in extent, and if the previous temperature was high enough to give rise to sufficient evaporation. Obviously the most favourable circumstances for augmenting the deposit would be cooling one side, while the rest of the vessel was warm enough for the evaporation to go on.

FURTHER RESEARCHES ON THE DISSOCIATION OF WATER BY H. ST. CLAIRE DEVILLE.

In a second paper read before the French Academy,* M. St. Claire Deville observes that when one or two kilogrammes of melted platina are thrown into water, an abundant discharge of explosive gases (oxygen and hydrogen) takes place, mixed with a certain quantity of nitrogen, "which is dissolved in the water, and which the heat sets at liberty." "This," as he observes, "is a repetition on a large scale made by Mr. Grove." "How is it," he asks, "that platina fuses so readily under the influence of the temperature developed by the combustion of oxygen and hydrogen, and that platina when melted, or merely heated to whiteness, decomposes water?" To reply to these questions he made certain experiments, which are thus described:— A porcelain tube, five or six centimètres in diameter, was carefully filled with perfectly clean fragments of porcelain, which had been heated to redness. A rapid current of carbonic acid was made to traverse the tube, having passed through a vessel of water at from 90° to 95°C. Lastly, the tube was brought to a high temperature by a furnace supplied with dense fuel, and urged by bellows. A small quantity of the vapour of water was decomposed, and, being collected over a solution of potash, yielded—

Oxygen	46·1	46·8
Hydrogen	35·4	31·9
Carbonic oxide . . .	12·0	10·7
Nitrogen	6·5	10·6
	100	100

Thus the dissociation of water can be accomplished without the aid of the porous tube mentioned in the previous paper,† but the quantity of gases obtained is four times less.

* *Comptes Rendus*, 23rd February, 1863.
† See Intellectual Observer for April.

M. Deville then inquires why the elements of water do not re-unite as the cooling takes place. The first reason he considers to be a physical one, arising from the well-known incombustibility of an explosive mixture scattered through an inert gas, such as carbonic acid or nitrogen. Such a mixture, he remarks, resists the electric spark, and does not inflame on the application of a lighted taper. It cannot, however, he adds, slowly traverse a porcelain tube filled with fragments of porcelain at a red heat without a re-union being effected.

A second physical reason he ascribes to the velocity with which he caused the gases to pass through the tube, and which affected the rapidity of the cooling, and their return to the temperature at which oxygen and hydrogen do not unite when diffused through a large quantity of carbonic acid. Upon this principle he explains the escape of the gases when melted platina is thrown into water. The oxygen and hydrogen, thus dissociated, rise quickly through the water, and become too cold to re-unite, and the resistance to reunion is augmented by the nitrogen shown to be present. In operating with the vapour of perfectly pure water, passed rapidly through a heated platina tube, recomposition followed dissociation, as he considers, because the presence of the inert gas was wanting under these circumstances, and because the considerable latent heat of the vapour of the water prevented rapid cooling.

MOSSES FOR THE MICROSCOPE.

BY M. G. CAMPBELL.

Mosses are divided into two grand sections, the *Acrocarpus*, or *summit-fruited*, so called from bearing their capsules, or fructifications, at the summit of the stem; and the *Pleurocarpus*, or *side-fruited*, thus named because their fructification proceeds from the side of the principal stem.

Of the first of these great divisions, the *Polytrichum formosum* and the *Polytrichum commune* are now putting on their golden calyptras or veils; and though the fruit of either does not ripen till June, they are, even in the present month, conspicuous from their size, and from their gold-coloured hairy veils.

The genus *Polytrichum* may be classed among the tallest and most showy of our native mosses; of perennial habit, and growing in uncultivated places, dry or moist, especially on heaths and in woods. They are distinguished by their pris-

matic apophysate * capsule, and the peristome † in general has sixty-four teeth, rarely thirty-two; are named from πολυς, many, and θριξ, hair; and we notice them first, not only because their appearance is striking, but because the true structure of the sporangium, or spore-case, *i. e.* seed-vessel, and of the columella ‡ of mosses, may be most easily seen by a careful microscopic examination of the unripe capsules of the various species of this genus, where it will be noticed that the columella or central pillar is separated from the spores by the inner portion of the sporangium, and the diaphragm, which is attached to the peristome, constitutes the dilated apex of the columella, the lid being filled up with cellular tissue which seems to have a distinct origin. The peristome, as in other mosses, is a continuation of the inner layers of tissue, composing the theca or spore box, but in some species there are traces of an inner peristome, united into one mass with the outer teeth, while proceeding from the sporangial membrane.

P. formosum has a simple elongated stem, with spreading leaves of a linear-lanceolate form, with a sheathing base, acute, sharply serrated, and plane. The capsule from four to six angled, pale brown, obscurely apophysate; lid conico-rostrate, or conical beak-shaped, calyptra large, stems, when full grown, from three to six inches long, grows in loose tufts, seldom branched. The capsule is oblong, at first erect, but subsequently horizontal. The rostrate lid is half as long as the capsule, or sometimes even longer; the calyptra covers the greater part of the capsule, sometimes quite envelopes it. The teeth of the peristome sixty-four, pale and rather short, while the basilar, or basal membrane, is very narrow, scarcely rising above the mouth of the capsule. Habitat, woods, etc. The writer has found it in some abundance in a damp dell, at the foot of Ferny Hills, Nailsworth.

P. commune so nearly resembles the above as to be sometimes confounded with it, but it may easily be known by the form of the capsule, which in *formosum* is often five or six angled, with a more obscure apophysis, and a longer conical rostrate lid, as well as by the consistence, that of *formosum* being soft, and of a pale fawn colour, while the capsule of *P. commune* is comparatively shorter, acutely four-angled, and distinctly apophysate, with perichætial § leaves, which *formosum*

* An apophysis is a swelling. In this case apophysate means with a swelling at the base of the capsule.

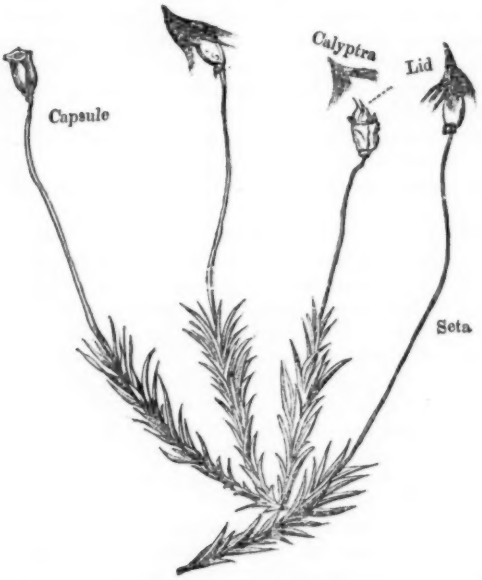
† Peristome, from περι, about, or round about, and στόμα, the mouth; in mosses, the beautiful fringe of teeth at the opening of the capsule.

‡ Columella, the little pillar, or central axis round which the sporules are seated.

§ From περι, around, and χαιτη, the name of bristle. The name is given to the leafy sheath of the bristle or slender stem which bears the capsule of mosses, and is botanically called *seta*.

has not; the calyptra is also larger, and of a deeper, richer colour, orangy, inclining to red.

There are four or more varieties of *P. commune*, one growing in marshy places, and attaining a length of stem from six inches to a foot; another on heaths in drier situations; a third on dry heaths, rarely attaining more than two inches in length of stem. A fourth variety is found on the drier part of moors in mountainous districts, and has branched pyramidal stems; while the ordinary form has only simple elongated stems, with leaves widely spreading and recurved, linear-lanceo-



POLYTRICHUM COMMUNE.

late from a pale sheathing membraneous base, serrated, and with bifid or cleft lamellæ at the edges. The seta, or fruit-stalk is reddish, and from two to three inches long; the capsule sharply quadrangular, and of a reddish brown. Most muscologists are agreed as to the distinctive name of this species, but Dillenius gives it the more graphic one of *P. yuccæfolium*, and with him some few of the German writers agree.

The preceding remarks may assist those who are in search of microscopic objects, to discover some of the most beautiful offered by the vegetable world at this, or it may be said, at any

season of the year, and to such as have not yet examined the exquisite loveliness of their form, and the marvels of their economy, the investigation of this minute tribe will open a world of beauty of which, till known, they can form no conception.

In examining mosses, all their parts should be submitted to the most careful scrutiny; the leaves are excellent examples of simple structure; the calyptræ, or veils, are interesting opaque objects, and may be easily preserved, as may also the whole plant, by putting under pressure nicely arranged specimens, and when dried, pasting them on note or letter paper; and if it be desired at any time to see, in its natural freedom, a particular specimen that may not be easily procured, all that is necessary to be done is to place the dried moss in a saucer containing a little lukewarm water, and in a few minutes the spray will drink in enough to enable it to stretch itself at pleasure, and thus the vital phenomena may be observed even after the plant has been kept in a dry state for years, a quality extremely useful in examining some species whose foliage shrivels up when dry.

The capsules should be watched throughout their growth, and especially when the lid falls off, disclosing the exquisitely formed and coloured teeth of the peristome, often in their structure displaying a chiselling and designs that no carved oak can rival. They should be treated as opaque objects, and viewed with an inch objective and a Lieberkuhn, or if the latter instrument be wanting, the illumination can be obtained by a bull's-eye lens. The spores are very small, and those who wish to trace their growth may sprinkle them on a piece of damp stone, covering it with a glass.

The fructification of mosses is more complicated than was formerly supposed. As Dr. Carpenter observes, "the capsule, or urn, is not the real fructification, but its product, for mosses like liverworts possess both antheridia and pistillidia." The antheridia of *Polytrichum* are elongated bodies, producing *sperm cells*, and these, acting on the *germ cells*, give rise to the spore capsules, or urns.

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PASTEUR ON INFUSORIA AND FERMENTATION.

M. PASTEUR'S previous researches on fermentation have been explained in the INTELLECTUAL OBSERVER, and we have now to give an account of some fresh investigations, recently laid before the French Academy.*

M. Pasteur commences his narration by adverting to his discovery of an *animal* ferment, the alleged "animal," to which other observers may not so readily concede that title, having the singular property of living entirely without oxygen or atmospheric air, and giving rise to the *butyric fermentation*. He repudiates the formerly accepted chemical theory of the changes that take place when sugar or lactic acid experience that peculiar fermentation, and ascribes it to a species of vibrio, the germs of which are disseminated by the air. Now, he tells us he can adduce a new example of fermentation, namely, that of tartrate of lime, which is determined by an infusorial animalcule, a vibrio, living without free oxygen, but very different, in appearance at least, from that which induces the butyric fermentation.

He places some tartrate of lime in water with a minute quantity of phosphates, earthy and alkaline, including that of ammonia. These salts may be artificial, or contained in the ashes of yeast, or the ashes of infusoria of the same kind. The vessel employed is a flat-bottomed flask with the neck drawn out and united to a curved tube of glass. The flask is filled with pure water after having received the tartrate. The contents are then exposed to ebullition, by immersing the flask in a bath of chloride of calcium, while the curved tube is plunged in a water bath, which is also boiled. By this means the air is expelled. The surface of the water in the vessel into which the curved tube is plunged, is finally covered with a thick layer of oil, and the whole apparatus allowed to cool for twenty-four hours. Under these conditions, the tartrate evinces no disposition to ferment; but if a few of the infusoria resulting from the spontaneous fermentation of tartrate of lime are introduced, they progressively multiply, and the tartrate gradually disappears, giving place to a deposit formed of the carcases of the vibrions, which are about one thousandth of a millimètre in diameter, and of variable length, sometimes reaching the twentieth of a millimètre.

When the water in the flask contains air, a race of monads and bacterium termo appear first, and after they have extracted the oxygen, the vibrions, which assist the fermentation, come into being.

* *Comptes Rendus*, 9th March, 1863.

M. Pasteur remarks that the preceding observations explain how readily fermentation occurs in solutions containing tartrate of lime, unless precautions are taken to exclude germs of the vibrions which excite it. At the surface of the liquid those infusoria multiply which consume the oxygen, and in the body of the liquid others spring up which require no oxygen, and which the former preserve from coming into contact with it.

M. Pasteur observes:—"The experiments described, and the composition of the materials employed, deserve particular attention, when we consider the primary cause of fermentation. Former theories regard the presence of albuminoid substances as indispensable requisites in all cases of fermentation, almost more so than the ferments themselves. According to my view, the *utility* (though not the necessity) of the albuminoid matters is recognized, because they afford a certain aliment to the ferment, the germs of which cannot be developed, and which cannot reproduce itself without the aid of nitrogen and phosphates. Thus there are two kinds of aliment which ferments find in albuminoid substances; but we may suppress plastic nitrogenous matter, if we replace it by a salt of ammonia mingled with alkaline and earthy phosphates. Moreover, it results from the composition of the tartaric liquid, that the sole carbonated element which the ferment can obtain is the tartaric acid which constitutes the fermenting body. We arrive, therefore, at the conclusion that the animalcule borrows all its carbon from the fermentible matter. There is no doubt—if we omit preconceived ideas as to the cause of fermentation—that under the circumstances we are now considering, there is a nutrition of the ferment at the expense of the fermenting matter, and that while the life of the infusory lasts, there occurs a transference of matter from the substance which ferments to that which excites its fermentation. The hypothesis of an action purely catalytic, or one of contact, is not admissible any more than the opinion which I now combat, and which assigns the character of a ferment exclusively to dead albuminoid materials.

Assuredly the fact of the nutrition of a ferment at the expense of the fermentible matter does not explain why the vibrio is a ferment. We know that the ordinary actions of vegetables and animals upon the intermediate principles which nourish them is not associated with fermentation, properly so called. But we must remember, in comparing the creatures previously known with those of which I now speak, that these animalcule ferments present a physiological peculiarity ignored up to this time, since they live and multiply without the presence of free oxygen gas. We are thus led to consider the fact of nutrition accompanied by fermentation, as a nutrition without the consumption of free oxygen. This, assuredly, is the secret of all

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fermentation properly so called, and perhaps of many of the actions, normal and abnormal, in the organism of living beings." . . . . "We can now affirm the existence of two kinds of living beings, one demanding the presence of free oxygen, the other which operates without contact with this gas, but which always manifests the character of a ferment. As to the number of beings that can live without air, and determine acts of fermentation, I believe them to be considerable, whether we speak of vegetables, that is to say, of organisms which exhibit no power of self-movement, or of animals, that is to say, of organisms whose motions have a voluntary appearance. I hope to demonstrate, in a subsequent communication, that the infusorial animalcules that live without free oxygen are *ferments of putrefaction*, when this act takes place sheltered from air, and that they are also ferments of putrefaction in contact with air; but in that case associated with infusoria or with moulds (mucors), which consume the free oxygen, and which fulfil the double part of agents of combustion for organic matters, and of preservers of the infusorial ferments from the direct action of the air."

CONSTRUCTION AND SILVERING OF GLASS SPECULA.

BY FREDERICK BIRD.

REFERENCE having been recently made by the Rev. T. W. Webb, of Hardwick, in his able and interesting articles on Celestial phenomena, to silvered glass specula as being applicable to the Newtonian telescope, and far superior to the old metals, and an intimation being given that several amateurs in England were, at the time, engaged in making these specula, of sizes from five up to twelve inches diameter, and that possibly the results of their labours might, in some form, be laid before the readers of the INTELLECTUAL OBSERVER—as one of the persons referred to, I have much pleasure in briefly narrating my own experience and the amount of success achieved with specula of this description, at the odds and ends of time saved from other and more pressing duties.

I was first induced to attempt a silvered glass speculum about two years ago, at the urgent recommendation of Mr. Webb, and commenced operations with one nine inches diameter, having a tube, brass cells, and other arranged parts of a telescope by me adapted to receive a speculum of that size. It was formed out of a piece of polished plate-glass, one inch thick, and after being roughly cut from the sheet with a dia-

mond, was finally ground to a square edge, made circular, and fitted accurately into the brass cell. The surface intended for the speculum was then reduced in the usual manner with emery and water, the work being done in my own polishing machine, until the curved surface was brought into agreement with the guage. It was then polished as perfectly as possible.

As all the errors of curvature, and its final perfection, lie concealed in that small quantity of the glass surface which can be removed in the process of polishing, the utmost pains were taken, in forming the polisher, in the selection and application of the materials, and in the careful variation of the stroke, to abrade the surface in such a manner as to generate as nearly as possible the parabolic curve, on which the perfection of the mirror depends.

The results of these labours were from time to time carefully tested by placing the speculum in its tube, and observing, in the most critical manner, the definition obtained of the minute figures and dots upon a watch-dial, placed at a distance of one hundred yards, and also by carefully noting the manner in which the much more minute discs of double and triple stars were exhibited. When no further improvement by the means then at command seemed probable, the surface of the speculum was considered ready to receive its coat of pure silver. The deposit was obtained by suspending the speculum face downwards in a solution of nitrate of silver, with other ingredients, according to a formula discovered by Professor Liebig.

For this important part of the process, I have to acknowledge the valuable assistance of Mr. With, of Hereford.

The bath, containing fifty ounces of solution, for silvering is prepared in the following manner:—

A large shallow vessel of glass or porcelain is provided to contain the solution, and should be wider than the speculum by two inches, and at least five inches deep. One hundred and fifty grains of nitrate of silver are dissolved in six ounces of distilled water; to this is added pure liquid ammonia, drop by drop, until the precipitate which is at first thrown down is re-dissolved. Two and a-quarter ounces of pure potash, called potassa fusa, are dissolved in fifty ounces, by measure, of rain water, and fifteen ounces of this solution are added to the ammonical solution, when a brown black precipitate is produced. Ammonia is again added drop by drop, until this precipitate is just re-dissolved; twenty-nine ounces of distilled water are then added to the whole. To this mixture is again added, drop by drop, stirring with a glass rod, a strong solution of nitrate of silver, until a precipitate, which does not re-dissolve, begins to be formed.

Previous to immersing the speculum, one part, by weight, of

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powdered milk sugar, to ten parts, by measure, of distilled water, must be prepared in a separate vessel, and filtered until a clear solution is obtained. Then to ten parts, by measure, of the silvering solution, must be added one part, by measure, of the milk sugar solution, and, finally, fifty ounces of the compound solution will be sufficient to silver a speculum nine inches diameter. As the success of the process depends greatly on the glass surface being made chemically clean previous to immersion in the bath, the utmost pains need to be taken to accomplish this object. The surface is first covered with thick whiting cream free from grit, and when dry is rubbed off lightly with the purest cotton wool. The surface is then wetted entirely with dilute nitric acid, and afterwards thoroughly washed with distilled water, by pouring over it, and last of all suspended in a flat vessel containing alcohol, where it remains until the bath is ready to receive it.

To facilitate the suspending, a circular block of wood is very firmly cemented to the back of the speculum with marine glue or pitch, and three pins inserted at equal distances round the margin to which the strings may be fastened. On lowering into the bath, care has to be taken that no air-bubble intervene, that the speculum be not deeper in the liquid than half its thickness, and that a depth of two inches, at least, intervene between the face of the speculum and the bottom of the vessel. In ten minutes after immersion a metallic film will be seen forming on the glass, and in an hour or two a compact silver coating will be laid over the whole surface.

The speculum should remain in the silvering bath for four hours, by which time the process is completed; it is then carefully removed, washed with copious applications of distilled water, and placed on its edge to dry.

As the deposit is covered with other matters which accumulate during the process, imparting to the surface when removed from the bath a dull and somewhat dirty appearance, it is necessary to remove these matters by a careful polishing. Fortunately, this may be accomplished without injury either to the curve or to the film, nothing more being required than a soft pad of cotton velvet stuffed with wool. It is first rubbed carefully with the pad alone, and afterwards with the addition of the finest rouge, by which means the surface may be polished to the highest degree of brilliancy, and kept free from scratches. This finishes the entire process.

So excessively thin are these films that they have been estimated not to exceed the twelve-millionth of an inch in thickness, and they are so far transparent as to transmit light through them, which is strongly tinted with a very rich blue colour.

They are also deposited with such extreme evenness and regularity as to assume the precise curvature of the surface to which they are attached, and in no appreciable degree interfere with the defining properties of the curve.

Being anxious to secure the greatest possible quantity of light from the silvered surface, I resolved to adopt the same principle with the small oval reflector, placed in the axis of the tube, to divert the pencil of light from the large speculum into the eye-piece. I made several "flats" of this kind, but finding great difficulty in preserving their figure during the polishing process, I searched, at the suggestion of Dr. Frankland, for pieces of the finest polished plate-glass, and was successful in meeting with some in all respects suitable for the purpose. Pieces were ground into the oval form, and when silvered, possessed the highest reflective properties, even surpassing those of a fine rectangular glass prism, with which I had the means of comparing them.

When the mirrors had been properly adjusted in the tube, their performance was carefully tested on some of the closest of the double stars, and although it was soon perceived that more false light played about the object than was anticipated, or could be detected when the speculum was unsilvered, yet the defining properties were so excellent and the light so magnificent, as to separate, very obviously, any stars not more than one second apart, while the faintest companions, usually to be seen with achromatics of five and six inches aperture, and then only in the finest condition of the atmosphere, were clearly distinguished.

As a few specimens of these objects, may be named 52 Arietis, all the components of which were detected without previous knowledge of its character, the close pair of the triple star ζ Cancri, η cor. Borealis, 36 Andromeda, 72 P II. Cassiopea, ψ Cassiopea, 12 Lyncis, the minute comes adjacent to λ Orionis, the fifth, and on several occasions the sixth star of the Trapezium, all the ten stars of σ Orionis, the clear elongation of ω Leonis, and γ^2 Andromeda, while the moon, planets, and their satellites were shown with the utmost splendour, and with excellent definition.

Since completing the nine-inch speculum, and finding it much less expensive than I had anticipated, I resolved on going a step further, and attempting one twelve inches diameter, which, after four or five months' hard labour, was completed and silvered on the 16th of March last.

It is mounted in a brass cell in an iron tube; has a focal length of eight feet nine inches, and weighs fifteen pounds. Up to the present time no favourable opportunity has occurred for testing its performance fully. At a trial, on the evening it was

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silvered, with 13 Messier, a resolvable nebula in mid distance between η and ζ Hercules, the appearance of the nebula, so called, was magnificent in the extreme, the field of view, almost up to its margin, being "powdered with stars innumerable in multitude."

A trial also on η cor. Borealis gave the components widely separated, with admirably defined discs.

I have every reason to believe that this speculum will command all the objects which only large achromatics of eight or nine inches aperture will reach, and if its defining qualities should equal its light-grasping power, I shall feel well rewarded for all the labour and the pains bestowed on its construction.

THE ANATOMY AND PHYSIOLOGY OF GASTROPODS.

THE DIGESTIVE SYSTEM OF THE *GREAT SLUG*.*

BY HENRY LAWSON, M.D.,

Professor of Physiology in Queen's College, Birmingham.

(*With a Tinted Plate.*)

We are too apt, in our zeal to become comparative anatomists, to seek in remote regions for some rare creature to dissect, forgetful of the fact that there are lying around us myriads of familiar beings whose structure, habits, and development are extremely interesting. There are many would-be *savans* who, though quite on terms of intimacy with the arrangement of the internal organs of a nautilus, or ornithorynchus, are lamentably ignorant of the anatomy of a snail, a fly, or a spider; and I do not fear to assert that such individuals have a species of instinctive contempt for the study of the structure of common animals, and would look upon the writer of an article upon the subject I intend to treat of with a feeling akin to horror. The class of persons to which I allude we should not despise, for they merit, if anything, our pity. I purpose in the following pages to give a general sketch of the form, structure, and use of the various organs which collectively constitute the alimentary system in the large black slug of our gardens and fields; but, before doing so, I think it of advantage to offer a few remarks regarding the mode of carrying out our operations, prior to entering upon the descriptive portion of the article. We must not go over the bridge till we come to it. Let us see, then, in the first

* For a more detailed description of the anatomy of this mollusk, consult the author's communication to the *Quarterly Journal of Microscopical Science* for January, 1863.

place, what apparatus we require. There are two things to be done.

First. The dissection of the animal.

Second. The microscopic examination of the dissected parts.

For the first we require some knives, needles, forceps, pins, pairs of scissors, and a small trough. The knives must be of different sizes; those supplied for the use of medical students will answer pretty well, but, if they can be obtained, it will be desirable to purchase a couple of the finer and more perfect instruments employed by ophthalmic surgeons. The form of blade which I have found of great advantage in dissection is simply a curve of steel, whose sharp edge is on the concave border, and which serves to cut away loose connecting bands without injuring the adjacent parts. The needles used must be of two kinds—the ordinary sewing ones and those in vogue among glovers. The latter forms are useful in dividing delicate filaments (*e. g.*, small branches of nerves, etc.), by pressing them against the trough, and which the scissors could not be brought to bear upon conveniently. Both forms should be fixed in solid wooden handles—those to which steel pens are attached will answer admirably, and *not* fitted to the universal handles in which crochet needles are placed. It will be well to bend two or three of the needles into different curves, to be used in looping up flocculent membranes, prior to their division by the scissors. The forceps may be of the kind that is to be found in the dissecting-case; it will, however, be of advantage to have two or three pairs of different sizes, and one also which is bent at the extremity. The pins must be of different sizes, and strong. The scissors should be of three varieties—a plain, long-pointed, *straight* pair; a long-pointed *curved* pair, whose blades are bent about the middle, at right angles to the plane of motion; and a pair of spring scissors, one blade of which is fixed to a long straight ebony handle, and the other acted on by a spring, so that, when passive, the two are separated from each other. The form of trough depends upon the taste of the operator. Some anatomists are accustomed to employ a wooden saucer, the bottom of which has been painted white; whilst others use a shallow white earthenware pan, to the bottom of which is attached a layer of cork. The utensil I approve of most is that recommended by Dr. Carpenter, viz., a square, very shallow box of gutta-percha, which the reader may prepare for himself as follows:—Take a sheet of thin gutta-percha, fifteen inches square, and having softened it in boiling water, turn up each edge at a right angle for about a depth of an inch and a-half, next press the corners together, taking care to make them waterproof, and the trough will be completed. For the microscopic examination we require an instrument of fair power,

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of the compound form, and also what is termed a simple microscope. I shall not here enter into the details of the mode of working with these apparatuses, but I would refer the reader to the valuable communication of Mr. Slack in the January number of the INTELLECTUAL OBSERVER.*

Having captured our slug, we put an end to his existence either by the application of ether, or, more simply, by immersing him for a few seconds in very warm water.† Nextly, we place him in the trough, and fix him to the bottom by means of two pins, one of which is driven through the caudal end of the creature, and the other through the fleshy projection beneath the mouth—both being allowed to penetrate the gutta-percha to a very slight extent. Here we see the object of the yielding, soft bottom; if we were to endeavour to carry on our dissections in a soup-plate or pie-dish, we should have no appliance to maintain the *subject* in one position, neither could we, when the organs had been exposed, have any means of separating them from one another.

Now, having arranged our specimen in the proper position, we at first remove the thick tegumentary covering, and the incisions which we make for this purpose will, in a great measure, depend upon the region which we propose to investigate the characters of. In this instance we require to study the digestive system, and we shall make the following incision:—Place the point of the curved knife between the lips of the respiratory orifice, which is situate upon the right side, near the middle lateral line, and about half an inch from the upper tentacle; then, being cautious to avoid damaging subjacent tissues, cut diagonally backward and toward the left side till you have completely divided the smooth black skin which forms the hood; here you will find a very decided stricture formed by bands of fibrous tissue; after a little manipulation, however, you will be able to insert the point of your blade beneath it, and then one slight movement upwards will remove the obstacle, and expose to view the contents of the abdomen. You will now alter the direction of your incision, and cutting in a right line toward the tail you will then perceive the entire abdominal contents as they are placed in the living animal. On making the first incision, the lungs were cut through, and also the bag which contained the shell, the pericardial gland, and the great vessels proceeding from the heart; when the constriction was severed, the fold of membrane separating the heart and heart-gland system from the abdomen was also divided.

* *On the Eye and the Microscope.* By Henry J. Slack, F.G.S.

† Should it, however, be desired to examine the structures closely, and whilst in the possession of their normal character, it will be well to dissect the animal while living, as re-agents of any kind affect the tissues less or more.

The digestive system we can now expose very easily by the aid of our needles and scissors; thus, in the posterior part of the body, we find the liver and intestines closely bound together by blood-vessels, which pass from one to the other, and are adherent to both; we place our curved needle beneath the gut, elevate it a little, and then, with our curved scissors, nick off the arteries, nerves, and connective-tissue fibres which serve to attach it to the liver. In the same manner in the anterior regions we separate the digestive organs from the reproductive apparatus, nervous ganglia, and any loose filaments which remain.

After we have advanced so far, we pour a small quantity of clean cold water upon the specimen, in order to wash away the particles of biliary matter which have escaped from the delicate lobes of the liver, and which so obscure the other structures that a perfect observation is impossible; this fluid we then decant, allowing it to escape over one of the corners of the trough (which we have slightly elevated at the opposite angle), and having filled the vessel with clean water,* we are now in a position to commence our study.

When we have dissected away the skin of the head, we recognize the alimentary system as a long canal, of a brownish green colour, travelling from the head throughout the body, in which it forms many curves and folds, to a small aperture beside the lung opening, where it ends—this latter being called the *anus*. Attached to this digestive tube, and, in fact, part of the entire system, we perceive two glandular structures near the head, a pair of very large brownish glands, which fill the abdomen, and a small sac. The first are the salivary or spittle glands, the second are the two moieties of the liver, and the third is the stomach.

The white, glistening round body, in which the mouth lies, is named the head. That portion of the canal which passes from the head to the stomach is styled the œsophagus or pro-stomach, the remainder being called the intestine.

We have to consider, then, the following organs:—head, œsophagus or pro-stomach, salivary glands, stomach, liver, and intestine.

The head is a solid, white structure, of a more or less spherical form when seen from above, but appearing oval when examined in profile; the large end is behind, and has projecting from its lower border a small, whitish, semi-transparent papilla. It is about a quarter of an inch long from front to back, and one-fifth of an inch from side to side; interiorly

* The water serves to render each organ more perspicuous by causing the soft, flocculent, membranous folds to float, and thus prevent the concealment of underlying parts.

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it is hollow, and has two apertures, one by which the food is introduced from without, and another that is continuous with the œsophagus. The anterior one is the true mouth; the cavity which intervenes between the external aperture and the opening of the gullet is readily divisible into two. Cut open the head with your scissors, dividing the upper, and *not* the lower portion, and you will then observe that there is at the back of the cavity a small pouch; this pouch we may designate the pharynx, and call the whole channel above, the mouth. You will find, if you examine the part of the head incised by the scissors, that there is adherent to it a horny, yellow palate, which is of a triangular form, and is bent downwards in front, where it plays the part of a maxilla, and when acting in concert with the fleshy lip, by which the oral orifice is guarded below, can grasp the leaves of plants and such like, which form the staple food of this animal.

The palate, or jaw, which I have just described, is about one-eighth of an inch wide and one-sixth of an inch long, and though attached to the fleshy wall of the mouth's roof above, can be easily detached, and is a pretty object for examination with the lens of the simple microscope. The pharynx, or sac of the mouth, is broad from side to side, and narrow in an antero-posterior direction, flat behind, and angular in front. It is lined with a roughened membrane, and has pointing from it, downwards and backwards, the small whitish teat or papilla which I alluded to above. This papilla projects like the finger of a glove, from the head, and when turned, as it were, inside out, it stands in the pharyngial sac. Now, since both the latter and the papilla are covered with a roughened coating, it follows that when any vegetable substance of a soft nature is placed between the two, and the papilla (or tongue, as it should be termed), moves to and fro, the intervening material will be pulpified. Before we go a step further, let us investigate the features of this membrane.

With a needle and small forceps, I tear a thin, semi-transparent lamina from the surface, place it upon a glass slide, moisten it with caustic potass, and cover it with a square of very thin glass.

Having put on the shallow eye-piece, and two-thirds inch objective, I now lay the glass upon the stage, and I perceive an exceedingly pretty object. The membrane is covered by a multitude of closely-set spines of a calcareous nature (*vide* plate, fig. 7), arranged in linear order side by side, the lines being placed one behind the other; each spine consists of a central portion or body, which is elliptical, and an exquisitely slender curved hooklet springing from this latter; the points of the hooklets all project backwards, and the spines are placed

one behind the other, and *not alternately*,* an exceedingly small rounded process rising from the membrane between every pair.

The functions of the head are two, those of prehension and mastication, deglutition being achieved through the contractions of the gullet. The first, I believe, is performed by the jaw and lip, which by their consentaneous action grasp the leaf, or other portion of vegetable matter, and bring it within reach of the pharynx; arrived here, it is acted on by the saliva, which has been introduced (in a manner we shall see presently) into this sac; then, by a series of complex movements of the tongue, it is submitted to a process of rasping between the hooklets of this latter and those of the pharynx, and eventually, having been reduced to a state of very fine division, it is tilted backwards by the tongue, and being within the reach of the œsophagus, is gradually carried onward to the stomach.

With a Valentin's† knife, I prepare a thin section of the tissue of which the head is composed; this I place on a slide of glass, and having laid it on the stage of the *simple* microscope, carefully tease out a small portion for examination with the higher powers of the compound one. The head is composed mainly of connective tissue, and as this is a form of web with which some of my readers may perchance be unfamiliar, I subjoin here a terse description. It consists of a more or less transparent bed or matrix, portions of which are *falsely* fibrillated (that is, have the appearance of being composed of fibres, although no such *structures* are present), containing in it occasional cavities of an irregular outline, denominated vacuoles, and having scattered through it, sparingly, delicate, curled fibres.

Besides this material there may be found muscular fibres ot the non-striated variety in the lower lip, and the tongue is almost entirely muscular from the spinous coat inwards.

The exceedingly loose, lace-like, and delicate organs, which hang like two beautiful white-stalked leaflets from the head, are the salivary glands; they are two in number, and lie, one on each side of the œsophagus during life. Each gland has a length of five-eighths of an inch, measures about a quarter of an inch from side to side, and pours its secretion (the saliva or spittle) into the mouth by a long and narrow duct, which passes from the gland beneath the large brain masses to the head; this latter it traverses, and it opens just above the pharyngeal sac, into which the saliva drops, thus rendering the process of pulpification of vegetable matter less difficult. These glands

* Lebert, in a communication to *Müller's Archives fur Anatomie*, 1846, states that the spines alternate; this I have shown to be an error. *Vide Quarterly Journal of Microscopical Science, loc. cit.*

† An instrument with two blades placed side by side, and which can be approximated or separated by means of a connecting screw. When a portion of an organ is divided by this knife, a delicate section is included between the blades.

are made up of a number of minute lobules, arranged in clusters upon the terminal ramifications of the ducts. Viewed under the microscope (with two-thirds of an inch objective) each lobule appears of an oval shape, filled with transparent fluid, and contains, floating in this latter, many well-marked circular endoplasts (*cells* of the older writers) with nuclei in their interiors, and has attached to its inner edge a delicate twig from the excretory duct. (See plate, fig. 3.) The œsophagus, or gullet—to use a more popular term—is a membranous conduit, or canal, which is narrow at first as it leaves the mouth, but which gradually widens, funnel-fashion, after it has passed the nervous collar, which in this as in other mollusks encircles the digestive track. It is usually of a dark brown colour, this being for the most part due to the presence of a quantity of bile it always contains, and which renders it not unlikely that much of the essential digestive operation is performed here. The œsophagus shows a tendency to conform to a curved arrangement, and in this particular resembles the intestinal division of the apparatus; hence, although at first it is situate centrally and horizontally, we find on its journey to the stomach it undergoes several twists; first, it turns to the left and downwards, and again bending to the right in the medial axis, and equidistant from the head and caudal extreme of the body, it terminates in the stomach. To see the œsophagus, it is necessary to remove the reproductive apparatus which bounds it on the right, the heart, heart-gland, lung, and shell-bag which cover it, and the fold of the intestine which lies on its left border. It is little more than two inches in length, has a calibre of one-sixth of an inch at the cardiac orifice of the stomach, and measures diametrically one-twelfth of an inch as it leaves the mouth. With regard to its histology, the œsophagus has the same structure as the intestine, and, therefore, the examination of the former will suffice for the latter also. Two coats enter into its composition—a fibro-muscular and pseudo-mucous; but neither of these can be detached without injuring the other. I take a slice with the assistance of the Valentin's knife—and here, *en parenthese*, let me observe, that in using this instrument the blades should be previously moistened, and the knife should be gently, but firmly, and in an *uniform* manner, drawn towards the operator, cutting at right angles to the surface—and having selected a portion from under the simple microscope, I place it in the compressorium, and examine it with the two-thirds and four-tenths of an inch successively. It then appears that the outer, or visceral lamina, is composed of two distinct strata of nucleated, non-striated, muscular fibres, crossing each other almost rectangularly, and has blended with these, and pursuing an undulatory course, a few of the delicate, elastic, *real fibres*

of connective tissue. The fibres of the muscular strata leave square spaces between them, which in very thin layers appear as transparent, quadrilateral intervals. The second, or inner lamina, is, one might say, devoid of structure, homogenous, and very difficult to prepare for examination. Most writers assert that it is covered with epithilium (collection of endoplasts); this, however, is not at all the case, no trace of even nuclei can be found; the entire stratum seeming to be a kind of protective glazing thrown out over the external layer.

Next comes the stomach. This viscus seems, in point of size, to be entirely out of proportion to the requirements of the digestive function; it is a small bag of an oval shape, and of a dark brown colour, into one end of which open together the œsophagus and intestine, so that these two appear to be continuous with one another, and the stomach seems but an appended sac. It is placed in the centre of an imaginary line, or axis, drawn from head to tail, lying *not* parallel, but transversely; it is attached by its right extremity to the gullet and intestine, but its left end is free, and lies loosely among the lobules of the liver; below, it rests partly on the foot or fleshy disk upon which the creature crawls, but, being uncovered above, it was one of the first parts seen on removing the integument of the abdomen. It is about half an inch long, five sixteenths of an inch deep, and a quarter of an inch wide. In structure the stomach resembles the œsophagus, and differs from it. It is composed of two coats, an outer-muscular and an inner mucous. The muscular coat contains *three* distinct strata of fibres: one longitudinal, the fibres of which travel round the stomach, starting from the œsophagus, and terminating at the intestine; a second transverse, whose fibres run at right angles to those of the latter; and a third oblique stratum, the fibres intersecting those of the others, diagonally cutting the quadrilateral spaces into triangles. (See plate, fig. 5.) The constituent fibres of these different layers are similar externally to those of the œsophagus, but their nuclei are larger and more distinct. The mucous layer is separated from the muscular by a very thin bed of structureless, transparent membrane; it consists of a collection of oblong endoplasts set endwise; the belt or zone of clear substance constitutes the plasma from which the two coats are developed—the muscular growing out, the mucous in; therefore, the inner lamina is truly exogenous and the outer endogenous; the two corresponding to the two strata of the skin of man, which are similarly separated and developed.*

* For an admirably clear and philosophic disquisition upon this subject, consult Professor Huxley's article on "Tegumentary Appendages," in *Todd's Cyclopædia of Anatomy and Physiology.*

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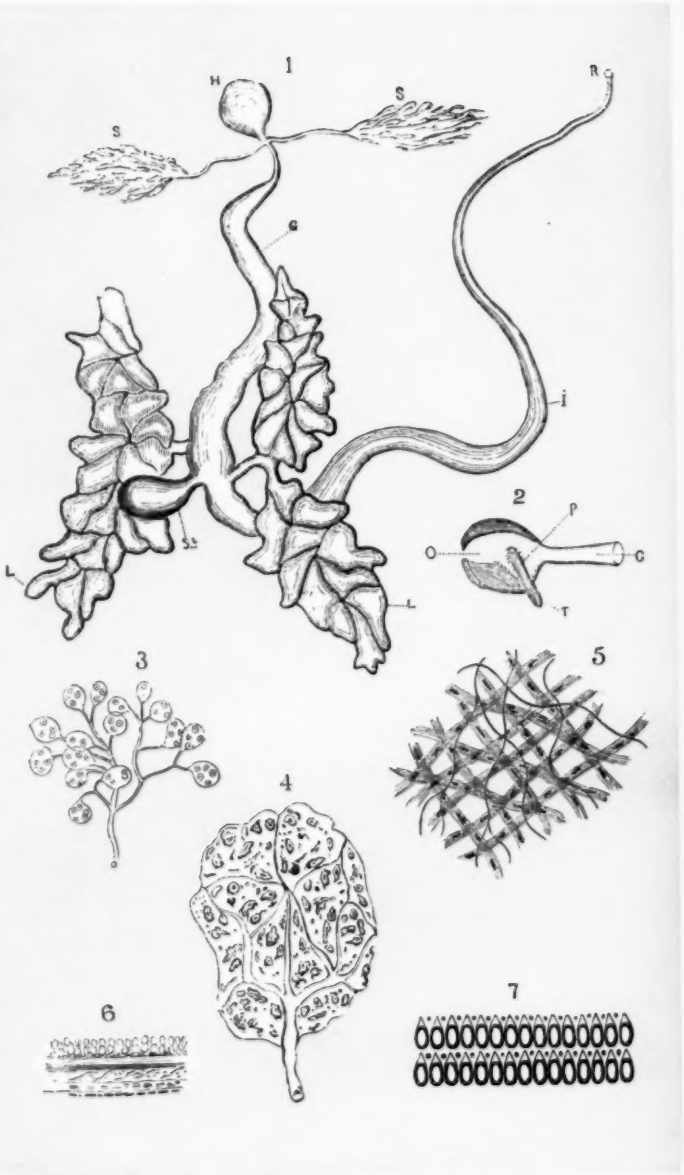
The intestine, or tube which conveys away the excrementatious portions of the food, is structurally but a continuation of the œsophagus; it is of the same width as this latter, as it leaves the stomach, but it gradually tapers till, at its termination in the anus, it measures transversely but one-half, or thereabouts, of its diameter at the pyloric orifice. It is (when removed from the body and extended) about seven inches in length: this seems astounding to any person ignorant of physiology, for it seems strange that a creature so low in the scale of organized beings should possess so long an alimentary canal. It, however, does not surprise the physiologist, who is aware that the intestines of plant-eating animals are invariably prolonged, from the circumstance that it is more difficult to digest vegetable than animal food, and that were there a short gut, the alimentary matter would have passed from the body before it had been deprived of all the nutritious materials it contained. The intestine is so folded and twisted about the other viscera that an enumeration of its relations would only puzzle the reader; sufficient to say, then, that on leaving the stomach it approaches the head; then curves backward toward the digestive sac, and again coming forward, ends by a minute aperture just above the respiratory orifice; it is through this opening that the fæces are expelled, and, therefore, it is properly called the anus. With a description of the liver I shall terminate this outline sketch of the digestive system. This is a most important gland, both in point of size and structure; it is composed of two parts, one on either side of the stomach, which resemble each other closely in size and form. Each half is in profile, like an ovate-lanceolate leaf, with jagged edges, and is built up of several large and small lobes, attached to each other by folds of connective tissue; from the various lobes small ducts travel, and by uniting with others, give rise to a considerable canal, which opens into the œsophagus immediately above the stomach; it is about two inches long, and fully half an inch wide. Every lobe is constituted of a series of still smaller divisions, called lobules. If we prepare one of these latter, and subject it to microscopic examination, we shall perceive that it is divided into a number of small compartments of an irregular outline, which contain numerous endoplasts, some with light-brown contents, and others without nuclei, and, in addition to these, a certain quantity of loosely-floating granules. The ducts which carry away the secretion of bile have *no direct communication with these compartments;* they ramify among them, and, in many instances, become converted into the fibrous tissue which forms the walls of the cavities. (See plate, fig. 4.) It is a remarkable fact that an English physiologist has pointed out the same structure in the liver of



H. L. ad nat. delt.

Digestive System of the Great Slug.

man,* and it seems to show that here, as in the human subject, the function of the gland may not be that of secreting bile *alone*.† The bile, or liquid secreted by the liver, is of a dirty, greenish-brown hue, with a faint odour, and a sweetish, nauseous taste. What its exact use is, it would be difficult to say, ignorant as we are of the function of the gall which our own hepatic organs form.

If the reader has distinctly grasped the descriptions contained in the foregoing pages, he will be in a fair position to begin dissections on his own account, and will then be enabled to perceive that, homely and vulgar an animal as is our common slug, it is yet not so entirely despicable as to be termed (what a lady once expressed to me as her opinion of its structure) *all squash*.

Explanation of the Plate.—Fig. 1.—The complete digestive apparatus of an average individual: *h*, head; *ss*, salivary glands; *g*, gullet; *st*, stomach; *ll*, liver; *i*, intestine; *r*, rectum. Fig. 2.—Ideal section (longitudinally and from above downwards) of the head: *o*, opening of mouth; *p*, pharynx; *g*, gullet; *t*, tongue. Fig. 3.—Clusters of lobules from the spittle gland—magnified. Fig. 4. Lobule of the liver highly magnified, showing how the duct becomes converted into the partitions. Fig. 5. Strata of muscular fibres from the stomach, with a few interblended filaments of connective tissue. Fig. 6.—Schematic vertical section of the wall of stomach; the endoplasts above, the structureless layer in the middle, and the muscular fibre beneath. Fig. 7.—A portion of the spinous membrane of the tongue, much enlarged, and viewed from above.

* *On the Structure, Development, and Function of the Liver.* By C. Handfield Jones, M.D., F.R.S. *Philosophical Transactions*, 1853.

† It is only fair to add that an opinion in opposition to that I have advocated above as to structure, is held by Dr. Lionel Beale, Professor of Physiology in King's College, and one who has given very considerable attention to this subject.

XUM

SMOKE-RINGS.

BY W. B. TEGETMEIER.

The phenomena presented by the spontaneous combustion of phosphoretted hydrogen are familiar to most persons who claim the title of Intellectual Observers. The rapid ascent of the constantly enlarging rings of smoke, produced by the combustion of the bubbles of gas, as they escape at the surface of the water, is no less striking than their peculiar property of spontaneous combustion. In the minds of most persons the production of these rings is associated with the peculiar chemical constitution and properties of the gas.

The object of the present paper is to disabuse the minds of my readers of this popular error—to show that the production of these rings is due to mechanical and not to chemical causes—to demonstrate their exact character, and to explain the numerous modes and interesting experiments by which they may be produced.

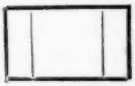
Firstly—The Production of Smoke-rings. Smoke-rings may be produced by a variety of means. The spontaneous combustion of phosphoretted hydrogen is one of the most interesting modes of demonstrating their production. The instructions given in most chemical works for the preparation of this gas are absurdly complicated and incorrect. I have always found that it may be prepared with great ease and safety by attention to the following directions:—Take a very small thin retort, capable of holding not more than an ounce or an ounce and a half of water; place in this three or four fragments of the sticks of fused caustic potash, each being about half an inch in length: add as much water as will barely cover them, and then drop in a small fragment of phosphorus, about the size of a horse-bean; apply a very gentle heat with the small flame of a spirit lamp, agitating the retort constantly. A pale lambent flame will first appear in the interior, and when this reaches the orifice and burns in the open air, the retort should be placed on the stand with the beak about an inch under water. Care must be taken not to withdraw the flame of the lamp. When the bubbles of gas so produced rise to the surface of the water they inflame, and a dense smoke-ring is formed, which rapidly enlarges as it rises. The bright spontaneous inflammation of the gas, and the production of these beautiful rings, renders this experiment one of the most striking character.

If our readers will turn to the Intellectual Observer, vol. ii. p. 387, they will find the account of a newly-discovered gas, consisting of silicon and hydrogen, which burns in the same

spontaneously inflammable manner, and with the same production of ascending smoke-rings.

There are examples of the production of rings by chemical means, but they may also be produced mechanically. Many practised tobacco smokers have acquired the trick of expelling from the mouth distinct masses of smoke which rise in this form, and a railway engine letting off sudden and separate puffs of steam, as when commencing its motion, not unfrequently produces the same phenomenon on a gigantic scale.

But the most interesting production of these rings by mechanical means has yet to be described. If six ordinary oblong cards, each about three inches by four, are taken and the ends folded down, after being partially cut through, so as to leave a central square, as here shown, they may with a little dexterity be combined into a very pretty cubical box. Previous to being put together, a circular hole about the size of a fourpenny piece should be cut in one card. If the box so constructed be filled with any dense smoke, such as that from a tobacco-pipe, or by allowing the vapours of hydrochloric and ammonia to enter together—smoke-rings in any number and at any desired rate of succession may be caused to issue from the hole in the box, by the slightest series of gentle taps on one of the sides. Their production in this manner is so facile, and so perfectly under control, that their formation constitutes—if the experiment be performed in a room in which the air is perfectly still—a very interesting and pretty experiment.



So much for the mode of producing these rings. Now let us consider their construction. If the reader has ever observed an ascending column of smoke on a perfectly calm day, he cannot fail to have been struck with the extreme beauty of its form —rising, perhaps, from the summit of one of those tall factory chimneys, now, alas! so smokeless; it ascends perpendicularly, spreading out as it rises, and gradually assuming the form of an elongated convolvulus, or, to use a less poetical and more homely comparison, that of a long funnel. This spreading out is due to the resistance of the air, which is greater, being more concentrated, towards the centre than at the outside. In a miniature form this ascending column may be examined by placing a piece of common phosphorus on a plate under a large bell jar; and I once saw it under peculiarly favourable circumstances;—as a large vessel steaming down the Thames turned into one of the reaches, it so happened that the direction of the river and that of the wind corresponded, so also did the speed of the vessel and that of the wind; consequently the tall column of dense black smoke from the funnel maintained for several minutes its

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perpendicular position over the moving vessel, which steamed along under this strange canopy, and looked as though she bore a gigantic palm tree whose top reached the skies.

If the reader can imagine the emission of smoke to be intermittent instead of continuous, it is obvious that this expanding column would be broken up into rings, the constantly enlarging circular form of which would be due to the same cause as that which produces the enlargement of the column, namely, the greater pressure of the air in the centre. That this is the case will be evident on a close inspection of a single ring, when it will be found to consist of a vast number of rapidly rotating circles, arranged on a circular axis. Let the reader imagine a number of common circular bone button moulds, each with a single hole through its centre, strung on a piece of wire, which is then bent in a circular form: this would give a correct idea of the structure of a smoke-ring; and if we imagine further each of these bone moulds rotating downwards and inwards, as the ring rises and expands, the resemblance would be still more complete.

RESPIRATORY ORGANS OF THE TADPOLE.

We have received the following interesting communication from Mr. Whitney, to whose researches on the tadpole microscopic anatomists are much indebted. Although investigations of this kind present many difficulties, the objects are fortunately plentiful, and the changes they undergo may, within certain limits, be postponed at the pleasure of the operator, who can place the tadpoles under more or less stimulating circumstances of food, temperature, etc. We have no doubt many of our readers will pursue the inquiry opened for them by Mr. Whitney, and we shall hope to give them an early account of the result of the labours in which he is at present engaged.

"In the last number of your Journal there appears an article 'On the Examination of Tadpoles,' in which the writer alludes to, and extracts from, a paper of mine published in the *Microscopical Journal* for January, 1862. In justice to your readers, therefore, I feel called upon to explain that the organs described in my paper as 'lungs' are *not* indeed the true lungs (meaning the organs adapted to purely atmospheric respiration), but the internal or *secondary* gills. The true lungs succeed to these.

"In some of our standard works on Comparative Physiology, the existence of *two separate and distinct pairs of gills* (*the one succeeding the other*), during the metamorphosis of the Tadpole, is neither expressed nor implied. Having taken one of these

works as a guide in the commencement of my investigation, I was led into the belief that the organs which succeed to the disappearance of the *external* or *primary* gills are lungs. This supposition was strengthened by observing that the Tadpole may be frequently seen at the surface of the water, rapidly opening and shutting its mouth as if in the act of swallowing air. In the course of investigation, however, I arrived at the correction of this error by discovering a pair of minute tubular sacs, placed abdominally directly below the heart, behind the intestine, and united at their upper and open extremities. These are the true lungs of the future frog, in their incipient, undeveloped state.

"There are, therefore, *three* sets of respiratory organs, the development and vascular arrangements of which, as they appear, exist, and disappear in succession, are most interesting and beautiful—most interesting to watch, most beautiful to see, but by no means easy to investigate.

"Should the writer be enabled to accomplish the task he has proposed to himself, and is now labouring to complete, he may have the opportunity of presenting an illustrated view of the transitional changes in the vascular system which accompany the several stages of this striking and beautiful metamorphosis.

"In referring to the paper which appeared in the *Microscopical Journal*, it will now be understood that the organs there designated '*lungs*' are the secondary, or '*internal gills*,' and that the blood circulating in them is aerated by the oxygen contained in the water that visits them. "W. U. WHITNEY.

"13, *Great College Street, Westminster, April 11th*, 1863."

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RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY CHARLES CHAMBERS.

1863.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2 P.M., and 5 P.M., respectively.		
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 9·30 A.M.
	inches.	°	°		inch.	°	°	°			inches.
Jan. 1	29·876	49·4	47·4	·93	·341	51·4	34·6	16·8	10, 10, 10	SSW, SW by W, SW.	·005
„ 2	29·589	42·1	37·4	·85	·241	45·3	42·6	2·7	9, 7, 0	W by S, SW by W, SW.	·237
„ 3	29·585	39·1	36·2	·90	·231	45·3	33·2	12·1	9, 3, 1	S, S by W, SW by S.	·008
„ 4	...	...	...	...	...	48·0	36·6	11·4	...	...	·156
„ 5	29·039	45·9	43·6	·92	·299	48·3	40·5	7·8	10, 10, 10	SSW, SSW, SE by S.	·200
„ 6	29·077	42·4	40·0	·92	·264	45·5	36·0	9·5	10, 10, 10	S by W, SE, ESE.	·320
„ 7	29·268	38·0	34·1	·87	·215	42·3	32·8	9·5	1, 6, 2	SW, SE, SE.	·240
„ 8	29·562	40·0	37·3	·91	·240	44·0	33·3	10·7	3, 1, 2	SE by S, S, SE by E.	·013
„ 9	29·722	36·5	37·6	1·00	·243	41·7	27·8	13·9	10, 9, 10	—, SE by S, SE.	·008
„ 10	29·678	37·8	32·9	·84	·206	40·2	28·7	11·5	10, 10, 10	E, NE by E, NE by E.	·006
„ 11	...	...	...	...	...	38·0	36·7	1·3	...	...	·096
„ 12	30·094	36·0	38·1	1·00	·248	44·7	22·3	22·4	7, 10, 10	NE by E, S by E, S by E.	·016
„ 13	29·871	41·1	38·8	·92	·253	42·8	25·8	17·0	10, 10, 1	N, SW by W, SW by W.	·622
„ 14	30·273	38·4	35·4	·90	·225	41·2	35·9	5·3	10, 0, 4	N, NNW, NW.	·051
„ 15	30·417	39·5	34·6	·84	·219	41·3	35·0	6·3	10, 10, 10	NE by N, NE, NE by E.	·008
„ 16	30·268	38·0	35·0	·90	·222	39·7	35·6	4·1	10, 10, 10	NNE, NE by N, NE.	·000
„ 17	30·111	37·1	33·2	·87	·208	44·0	35·7	8·3	10, 10, 10	NE by N, —, W.	·000
„ 18	...	...	...	...	...	48·5	32·1	16·4	...	...	·157
„ 19	29·461	47·3	35·6	·67	·226	49·9	40·3	9·6	8, 7, 10	WNW, W by N, W.	·000
„ 20	29·261	40·3	24·6	·57	·153	43·1	42·4	0·7	3, 4, 3	WNW, W, W.	·048
„ 21	29·722	42·5	33·3	·72	·209	45·3	38·2	7·1	9, 4, 10	W, W by N, W by N.	·010
„ 22	29·766	48·7	44·7	·87	·311	51·5	41·8	9·7	10, 10, 10	SW by W, SW, SW.	·011
„ 23	29·653	48·3	40·5	·76	·269	53·1	48·0	5·1	10, 6, 6	SSW, SW, W by S.	·000
„ 24	29·712	45·9	34·7	·68	·219	49·3	37·2	12·1	5, 5, 7	SW by W, WSW, WSW.	·056
„ 25	...	...	...	...	...	48·7	37·5	11·2	...	...	·000
„ 26	30·204	45·8	40·8	·84	·272	50·7	42·0	8·7	10, 8, 8	SSW, SW, SW.	·000
„ 27	30·175	43·9	31·1	·64	·193	46·3	45·3	1·0	10, 2, 1	WNW, W, W by N.	·020
„ 28	30·464	38·6	32·7	·81	·204	44·8	30·2	14·6	0, 10, 2	SW, SW, S by W.	·000
„ 29	29·820	49·2	43·8	·83	·302	53·3	33·8	19·5	10, 3, 2	SW by S, SW, SW.	·000
„ 30	29·515	49·2	46·5	·91	·331	50·9	46·0	4·9	10, 10, 10	SSW, SSW, SW by S.	·000
„ 31	29·477	45·2	39·1	·81	·256	49·3	45·6	3·7	8, 4, 7	SSW, NW, WNW.	·200
Monthly Means.	29·765	42·5	37·4	·84	·244	...	...	9·5	...	...	2·488

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—JAN. 1863.

Day.		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																	
12																																	
1	A.M.	17	34	11	26	18	15	10	8	2	20	13	4	16	5	11	16	16	18	20	28	25	15	27	11	23	15	34	6	17	25	23	17·1
2	A.M.	18	33	10	29	16	11	10	5	1	22	13	4	10	11	10	16	18	19	22	28	26	17	28	11	23	12	28	5	24	22	17	16·7
3	A.M.	17	36	10	32	17	6	10	5	3	24	10	3	10	11	14	18	19	23	23	31	23	20	30	11	23	13	26	7	20	27	12	17·2
4	A.M.	26	38	10	29	25	3	12	2	3	25	12	1	7	10	13	20	13	25	30	33	22	20	31	16	22	11	27	6	22	30	13	18·0
5	A.M.	23	44	2	27	30	3	6	3	1	19	13	1	7	15	12	20	13	25	25	39	23	23	30	17	17	12	22	5	22	28	12	17·4
6	A.M.	27	37	2	20	31	9	7	8	1	20	12	1	5	15	15	16	14	27	20	34	25	20	26	20	15	14	20	5	25	24	11	17·0
7	A.M.	27	33	7	21		4	7	9	1	21	10	2	7	17	12	16	12	23	26	37	21	27	32	26	15	20	24	5	26	21	13	17·4
8	A.M.	28	36	8	19		2	8	11	1	17	10	1	5	19	19	18		17	25	43	20	22	28	30	14	22	20	3	27	23	16	17·7
9	A.M.	30	26	11	15	115	3	3	8	1	27	7	3	7	14	19	16	48	14	22	37	21	25	35	33	11	25	19	3	28	25	15	17·3
10	A.M.	27	12	10	17		5	2	9	1	20	6	2	8	10	18	20		19	22	37	23	21	40	31	19	23	18	2	26	24	20	17·0
11	A.M.	31	14	13	18	25	9	4	5	3	30	7	3	6	10	13	17	8	21	22	36	23	20	41	31	23	24	19	7	25	27	12	17·6
12	A.M.	32	15	9	20	16	7	5	8	2	23	7	5	7	9	17	16	8	24	26	34	23	21	34	34	19	22	15	9	23	29	11	17·1
1	P.M.	35	17	16	18	14	12	4	4	12	22	6	14	7	9	15	19	6	24	30	36	26	23	28	31	18	26	20	15	27	30	11	18·5
2	P.M.	35	15	15	17	14	10	6	7	11	25	8	12	9	11	15	20	5	25	30	28	23	22	30	31	15	26	16	13	26	30	13	18·2
3	P.M.	33	16	15	14	13	8	7	7	13	25	7	16	10	7	17	20	3	20	26	33	21	21	18	28	16	27	18	12	26	28	16	17·5
4	P.M.	37	17	9	12	12	11	8	4	10	25	6	15	6	5	15	23	2	16	22	34	17	18	20	21	14	20	12	9	25	27	16	15·7
5	P.M.	34	12	10	15	11	12	11	6	11	25	4	20	5	6	18	21	5	16	17	29	12	23	22	24	14	27	11	8	24	27	15	16·0
6	P.M.	33	11	10	12	9	12	6	5	14	25	4	20	4	8	15	19	5	13	14	30	10	21	20	20	15	26	8	7	21	25	14	14·7
7	P.M.	34	12	8	11	12	18	9	4	12	22	4	20	6	10	15	20	10	17	14	27	10	25	13	20	16	23	11	6	19	25	11	15·0
8	P.M.	36	10	7	16	15	17	3	4	10	16	3	20	7	9	17	20	11	17	16	27	9	25	12	20	16	26	12	7	20	28	11	15·1
9	P.M.	38	12	9	18	18	13	7	6	8	16	6	22	6	7	14	20	14	16	19	24	12	19	10	16	15	30	7	11	20	32	9	15·3
10	P.M.	36	10	9	17	16	6	10	3	10	16	3	23	6	6	14	18	17	15	21	25	11	27	14	14	16	29	8	17	18	32	7	15·3
11	P.M.	37	9	16	12	20	6	12	5	14	15	3	20	6	7	15	19	20	15	24	29	15	25	15	16	20	37	9	19	15	34	10	16·7
12	P.M.	34	11	17	15	12	7	10	4	15	12	3	15	3	9	20	20	18	20	21	26	13	29	11	18	16	32	5	15	22	25	7	15·6
Total Daily Movement.		725	510	244	450	459	209	177	140	160	512	177	247	170	240	363	448	285	469	537	765	454	529	595	530	415	542	409	202	548	648	315	16·8

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1863. Day of Month.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2 P.M., and 5 P.M. respectively.		Rain—read at 9·30 A.M.
	Barometer, corrected to Temp. 32°*	Temperature of Air.	Calculated.			Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9.30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
			Dew Point.	Relative Humidity.	Tension of Vapour.						
	inches.	°	°		inch.	°	°	°			inches.
Feb. 1	...	...	...	...	...	48·2	34·2	14·0	...	... ...	·066
„ 2	29·900	46·0	43·5	·91	·298	48·5	39·3	9·2	10, 10, 10	SW, SW, SSW.	·050
„ 3	29·798	44·6	38·5	·81	·251	50·1	46·2	3·9	10, 8, 10	SW, WSW, SW by W.	·098
„ 4	30·137	43·2	40·0	·90	·264	49·5	32·8	16·7	8, 10, 10	SW, SSW, SW by W.	·000
„ 5	30·200	46·8	38·5	·75	·251	49·6	40·6	9·0	10, 3, 9	W by N, W by S, SW by W.	·017
„ 6	30·303	47·4	45·4	·92	·314	50·4	43·7	6·7	10, 9, 10	SW by W, SW, SW.	·000
„ 7	30·177	48·2	44·0	·87	·304	53·0	45·0	8·0	10, 9, 1	SW, WSW, SW by W.	·000
„ 8	...	...	...	...	..	47·4	42·7	4·7	...	... ...	·035
„ 9	30·186	38·5	30·4	·75	·188	43·5	30·2	13·3	1, 4, 3	W by N, WSW, SW.	·000
„ 10	30·198	44·4	39·9	·86	·263	48·5	36·6	11·9	10, 9, 9	SW, SW by W, WSW.	·000
„ 11	30·196	43·6	37·4	·81	·241	47·9	41·1	6·8	10, 4, 3	SW by S, SW, SSW.	·000
„ 12	30·381	43·5	34·4	·73	·217	48·5	39·3	9·2	5, 2, 1	——, NW, NW by W.	·000
„ 13	30·647	38·4	33·9	·85	·213	47·0	27·1	19·9	10, 4, 2	——, ——, E by S.	·000
„ 14	30·592	38·6	32·6	·81	·203	42·9	30·0	12·9	3, 1, 1	E by N, E by S, E.	·000
„ 15	...	...	...	...	...	45·0	30·3	14·7	...	... ...	·009
„ 16	30·620	39·6	27·8	·66	·171	48·0	26·2	21·8	3, 1, 2	ENE, SSW, SE by E.	·000
„ 17	30·589	39·7	32·3	·77	·201	48·3	23·2	25·1	3, 0, 1	NW by N, SSW, SSW.	·000
„ 18	30·468	37·7	34·9	·91	·221	47·6	25·2	22·4	10, 4, 8	W by S, SW, SW.	·000
„ 19	30·391	41·2	41·2	1·00	·275	45·4	29·5	15·9	10, 10, 10	——, ——, ——.	·142
„ 20	30·365	40·4	35·8	·85	·228	44·0	39·0	5·0	10, 8, 10	ENE, ESE, SE by E.	·067
„ 21	30·307	43·0	38·3	·85	·249	48·9	32·3	16·6	9, 8, 8	E by N, S by W, SSW.	·005
„ 22	...	...	...	...	...	47·5	36·1	11·4	...	... ...	·000
„ 23	30·293	44·3	37·9	·80	·245	48·4	32·5	15·9	9, 10, 10	SW by W, W, WSW.	·010
„ 24	30·331	42·7	40·2	·92	·266	46·1	42·5	3·6	10, 10, 10	NE by N, NNE, NE.	·000
„ 25	30·427	43·5	40·3	·89	·267	48·0	32·4	15·6	10, 10, 10	SW, SW, SW.	·005
„ 26	30·358	45·5	35·6	·71	·226	49·0	40·2	8·8	9, 9, 8	SW, SW by W, SW.	·000
„ 27	30·257	47·7	38·6	·73	·252	53·0	43.3	9·7	10, 5, 0	SW, SW by W, SW.	.000
„ 28	30·216	45·2	37·5	·77	.242	52·7	32·2	20·5	10, 4, 2	SW, SW, S.	·010
Monthly Means.	30·306	43·1	37·4	·83	·244	...	...	12·6	...	... ...	0·514

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—FEB. 1863.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Hourly Means.
Hour. 12 1 2 3 4 5 6 7 8 9 10 11 A.M. 12 1 2 3 4 5 6 7 8 9 10 11 12 P.M.	8 6 7 5 9 13 19 21 24 27 26 25 16 14 16 17 14 11 13 12 14 13 12 15	15 6 18 19 17 21 23 24 26 24 25 26 28 25 24 22 26 24 25 26 22 24 22	23 15 21 18 19 18 21 18 15 15 15 18 16 15 14 21 23 14 10 8 9 8 10	12 10 10 10 17 11 18 10 13 15 13 10 7 16 13 18 14 23 11 7 11 9 10	26 20 16 17 16 17 12 15 10 11 10 13 14 16 13 11 10 7 11 12 13 11	12 17 13 16 15 5 11 13 14 10 13 14 13 12 11 12 14 7 10 7 8 7 6	13 5 12 5 5 5 7 14 3 6 2 4 11 13 6 9 7 10 7 11 8 11 6	6 5 7 8 7 6 5 6 7 5 6 4 12 10 9 6 5 6 7 8 9 11 8	8 7 6 8 7 5 6 7 5 6 13 12 15 10 13 11 10 11 12 9 11 12 11	11 12 9 12 8 7 6 5 6 13 11 13 15 19 21 21 23 20 18 15 12 15	10 9 5 5 4 1 0 1 2 1 0 2 7 9 6 6 3 4 2 3 4 3 4 3	4 2 1 1 3 0 1 2 3 3 2 1 1 2 1 1 1 1 1 1 1 1 1	4 2 17 16 25 12 24 28 31 28 23 22 14 25 23 27 17 13 20 19 8 2 13	10 15 6 3 11 10 12 16 22 23 22 14 21 23 25 17 13 14 22 19 6 2 10	8 5 3 3 5 5 7 2 6 8 5 4 5 5 4 3 5 5 5 5 3 3 3	3 4 0 1 2 1 2 1 2 2 1 1 2 1 1 1 1 1 1 1 1 1 1	1 3 5 4 3 2 1 2 2 1 2 2 1 2 2 1 1 1 1 1 1 1 1	4 3 6 5 3 3 2 3 2 2 1 2 2 1 2 2 1 1 1 1 1 1 1	2 3 6 6 4 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	7 6 6 4 3 4 4 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3	5 6 5 4 3 3 4 4 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	4 5 8 7 6 5 4 3 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	8 10 10 11 12 12 11 12 12 11 12 12 12 12 12 12 12 12 12 12 12 12 12	10 12 10 11 9 12 11 16 14 18 17 15 16 16 16 13 10 11 13 15 16 16 16	6 5 3 1 2 3 4 4 3 4 3 2 3 2 3 3 3 3 3 3 3 3 3	8·8 8·7 8·0 7·7 8·2 8·5 8·7 8·7 8·5 10·0 11·6 12·3 13·2 13·7 13·0 11·9 11·2 9·7 9·8 10·1 9·6 9·2 9·9 8·9
Total Daily Movement.	361	550	366	453	316	287	269	209	194	296	305	142	115	430	308	114	74	136	76	167	146	193	191	159	139	309	281	126	10·0

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1863.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2 P.M., and 5 P.M., respectively.		Rain—read at 9·30 A.M.
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°			inches.
March 1	...	...	...	...	...	49·4	38·9	10·5	...	...	·000
„ 2	29·893	49·4	46·5	·90	·331	55·3	41·0	14·3	10, 10, 9	S, SW by S, SW.	·010
„ 3	29·781	52·6	35·7	·56	·227	60·4	43·3	17·1	0, 0, 0	SSE, SSE, SE.	·000
„ 4	29·633	51·5	41·4	·71	·277	60·4	37·0	23·4	5, 5, 3	—, S by E, S by E.	·000
„ 5	29·651	49·4	41·9	·77	·282	57·3	32·2	25·1	3, 7, 5	S, SSE, SE by S.	·000
„ 6	29·426	46·7	42·3	·86	·286	53·0	42·9	10·1	5, 7, 10	SSE, S, S.	·000
„ 7	29·514	41·1	37·3	·88	·240	48·4	38·2	10·2	9, 10, 10	SSW, S by W, S by W.	·070
„ 8	...	...	...	...	...	45·1	33·3	11·8	...	...	·224
„ 9	29·517	37·8	25·3	·64	·157	43·4	29·1	14·3	3, 5, 9	W by N, W by N, NW by W.	·079
„ 10	...	...	...	...	...	43·3	28·2	15·1	...	...	·005
„ 11	29·591	35·9	29·0	·78	·179	42·0	32·6	9·4	8, 7, 1	N by E, NNW, WNW.	·008
„ 12	29·216	37·8	36·7	·96	·235	42·3	25·5	16·8	10, 10, 10	SE, SE by E, SE.	·006
„ 13	29·324	41·8	34·2	·77	·215	49·8	31·5	18·3	3, 4, 4	NW, WNW, N.	·030
„ 14	29·363	39·5	32·9	·79	·206	47·8	25·6	22·2	8, 9, 8	—, S by W, SE.	·007
„ 15	...	...	...	...	...	44·3	34·6	9·7	...	...	·140
„ 16	29·927	41·1	31·1	·70	·193	45·0	36·0	9·0	8, 10, 9	N, N, N by E.	·053
„ 17	30·194	39·4	30·8	·74	·191	44·5	33·7	10·8	3, 5, 2	NNW, NW by N, NNW.	·011
„ 18	29·950	38·5	25·5	·63	·158	44·7	27·8	16·9	3, 6, 5	—, NNE, NNW.	·000
„ 19	29·983	43·0	32·1	·68	·200	48·9	34·1	14·8	5, 7, 4	NWbyN, NWbyW, NWbyN.	·000
„ 20	29·853	46·9	39·2	·77	·257	55·2	37·1	18·1	10, 5, 10	SW, NW by W, WNW.	.031
„ 21	30·101	45·9	34·7	·68	·219	51·2	43·8	7·4	7, 9, 10	NW, N, N by W.	·000
„ 22	...	...	...	...	...	55·9	30·5	25·4	...	...	·004
„ 23	30·400	49·8	41·7	·76	·280	59·0	38·3	20·7	7, 6, 6	SW, WNW, WNW.	.000
„ 24	30·443	52·7	42·0	·69	·283	59·6	38·2	21·4	0, 1, 0	SW, N by W, N.	·000
„ 25	30·462	52·6	42·2	·70	·285	60.7	35·4	25·3	9, 0, 0	SSW, —, W by S.	·000
„ 26	30·305	49·7	38·9	·69	·254	57·6	37·0	20·6	8, 7, 4	W by N, W by N, W by N.	·000
„ 27	30·321	47·1	34·2	·64	·215	53·7	34·8	18·9	2, 9, 7	NW, W by W, W by N.	·000
„ 28	29·913	51·1	36·6	·61	·234	55·9	42·4	13·5	8, 10, 10	WSW, NW by W, W by N.	·000
„ 29	...	...	...	...	...	55·9	47·2	8·7	...	...	·005
„ 30	30·005	47·9	40·6	·78	·270	53·1	47·1	6·0	9, 9, 10	NW by W, N by W, NNE.	·000
„ 31	30·219	43·2	32·7	·69	·204	49·7	39·7	10·0	10, 3, 1	SE, E by S, E.	·000
Monthly Means.	29·879	45·3	36·2	·74	·235	...	...	15·3	...	...	0·683

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER—March 1863.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																
12																																
A.M. 1	10	10	8	3	1	4	19	11	7	1	5	1		3	2	14	14	4	3	6	27	3	6	4	2	6	7	15	15	11	12	7·8
2	10	4	9	7	2	8	19	10	8	0	4	1		1	2	15	13	5	5	5	26	1	6	4	2	9	10	15	13	14	15	8·1
3	11	5	10	8	2	7	17	9	5	1	5	3		1	1	16	16	5	6	6	25	2	6	5	1	7	9	15	16	8	15	8·1
4	13	5	7	7	1	6	16	8	6	1	5	5		1	4	17	15	6	7	7	24	2	4	4	2	6	4	18	17	10	14	8·1
5	11	9	8	6	3	8	11	11	4	1	5	6		1	3	19	14	5	5	14	23	4	7	3	1	7	4	20	21	11	13	8·6
6	14	2	7	7	2	11	11	10	5	0	5	5		0	2	14	13	4	5	11	21	3	5	4	3	5	3	17	10	9	12	7·3
7	18	7	9	7	1	14	10	10	4	1	7	8		1	4	19	13	1	12	14	22	2	8	3	2	7	4	18	15	8	11	8·7
8	18	15	9	3	3	15	9	10	6	1	8	15		1	2	20	12	2	12	16	22	2	7	3	1	7	5	19	17	9	13	9·4
9	15	18	10	2	1	19	6	13	6	2	10	15		1	4	21	16	2	12	17	22	3	7	4	1	11	10	16	17	11	12	10·1
10	19	19	15	1	1	22	11	17	5	3	10	16		1	4	25	19	1	14	18	20	5	5	5	2	15	12	20	18	10	10	11·4
11	27	23	15	0	12	29	12	15	4	2	14		3	8	5	26	18	2	19	19	23	4	7	6	2	15	14	28	20	11	10	13·1
12	25	21	15	6	12	31	12	20	7	3	13		4	17	10	25	21	5	17	10	21	8	8	6	4	17	13	28	27	8	8	14·1
P.M. 1	28	24	18	8	12	25	12	19	5	6	10		5	19	10	25	18	4	16	22	18	6	12	6	5	17	15	28	21	8	10	14·4
2	23	35	18	7	14	29	14	20	8	9	11		6	20	10	22	17	6	14	22	17	9	8	7	5	19	15	26	23	7	10	15·0
3	19	24	17	9	15	29	13	12	5	7	9		5	18	11	24	19	6	14	25	17	8	13	8	3	17	17	25	24	7	11	14·4
4	18	21	16	8	15	33	13	16	2	5	15		5	15	15	23	19	10	13	26	12	9	12	6	5	15	18	24	19	8	14	14·3
5	18	22	13	12	13	27	11	16	3	4	15		4	11	10	22	16	7	10	21	11	8	14	6	2	19	16	21	19	9	13	13·1
6	14	19	10	11	7	23	10	18	1	5	6		4	9	3	22	9	6	5	21	6	6	7	4	3	13	15	23	18	6	15	10·6
7	12	12	9	9	2	18	9	21	0	6	5		1	4	6	16	5	5	3	21	5	5	5	4	5	8	15	21	16	18	15	9·4
8	14	8	10	4	6	18	10	20	1	5	5	220	2	4	8	18	3	2	5	23	6	4	3	5	7	10	10	18	11	17	15	9·1
9	11	6	9	3	2	18	6	16	1	3	5		2	2	9	14	3	3	3	21	4	4	5	5	4	12	11	21	9	16	12	8·0
10	10	9	7	2	4	23	1	18	1	5	5		2	3	8	15	3	5	4	32	3	6	3	1	4	17	11	22	11	15	10	8·7
11	8	9	5	1	4	19	6	11	1	4	6		3	2	13	15	4	6	7	20	3	9	5	1	5	18	13	20	10	18	9	8·5
12	6	8	3	0	4	18	12	15	0	4	2		2	1	12	15	3	5	4	18	1	6	5	1	5	11	15	17	10	15	7	7·5
Total Daily Movement.	372	335	257	131	139	454	270	346	95	79	185		343	144	158	462	303	107	215	415	379	119	168	105	76	288	266	495	397	264	286	10·6

XUM

ASTRONOMICAL NOTES.

PLANETARY SYSTEMS AMONG THE STARS.—ECLIPSES.—PLANETS OF THE MONTH.—TRANSITS OF JUPITER'S SATELLITES.—OCCULTATION.

BY THE REV. T. W. WEBB, M.A., F.R.A.S.

PLANETARY SYSTEMS AMONG THE STARS.

THE assertion so frequently made, and so generally accepted, that our sun is one of the fixed stars, is of course incapable of demonstration. Its probability seems to rest chiefly upon two arguments—that the light of the stars is evidently of the same intrinsic and self-developed character with that of the sun, and that the sun, if viewed at a distance equal to that of the stars, would undoubtedly appear no otherwise than as one of them; and since no more direct proof can be obtained, we are willing to receive these as sufficient. But this point once admitted, it is evidently consistent with all analogy to proceed a step further, and to suppose that these other suns, or at least the insulated ones, may be, as our own, the centres of light and heat and gravity, and electrical and chemical influences, to groups of surrounding worlds. The idea is a magnificent one, and in full accordance with every other declaration of the glory of God in the heavens, and it would be no matter of surprise at any time if observation were to give us direct evidence of its truth. Nor would it necessarily follow that the highest class of instruments would be required for the detection of these planetary systems, though so wonderfully remote in the depths of space. Analogy may point the way in many cases where it ought not to interpose a check, and the diminutive size of our planets in comparison with their ruler affords no adequate inference that in other systems a very different arrangement may not obtain. It was a noble expression of old Bianchini's, "Quis unquam exhaustas dixerit cœli copias!" and all the subsequent progress of astronomy has proved, from more comprehensive premises, the justice of his conclusion.

And thus, although planets no larger than our own might ever remain invisible at the distance of the fixed stars, it is not merely possible, but may be even probable, that bodies of a similar nature may be connected with other suns, of sufficient magnitude to be visible with our instruments, especially in their modern state of improvement. The idea was thrown out by Sir J. Herschel, many years ago, that certain very minute points, closely associated with larger stars, may be visible by reflected or planetary light; and he specified among others, ι Ursæ Majoris, γ Hydræ, κ Geminorum, and the *comites* of a^2 Cancri

and a^2 Capricorni; but it does not appear that these suspicions have been verified, or that the matter has been subsequently investigated, notwithstanding its obvious interest and importance.

The subject, however, has been brought afresh before us by M. Goldschmidt's recent assertion that, with an object-glass of little more than four inches aperture, he has not merely perceived Alvan Clark's companion of Sirius, which has hitherto been supposed to be reserved for the largest and most perfect instruments, but has detected five additional companions of the same character, at somewhat greater distances, varying from 15″ to 1′; and, in announcing this discovery, he suggests an inquiry as to whether the object discovered by A. Clark may shine by native or reflected light, which may of course be extended to the rest. It seems remarkable that the colossal telescopes of Clark, Bond, Lassell, and Chacornac, in which the nearest of these alleged attendants has been perceived, should have given no indication, as far as has hitherto been stated, of the other five; but no doubt immediate attention will be paid to so interesting a point. M. Goldschmidt has distinguished himself as the discoverer, with comparatively very inadequate instrumental means, of no less than fourteen of the small planets intervening between Mars and Jupiter, and has, on that account, received one of the most honourable of testimonials, the Gold Medal of the Royal Astronomical Society,* so that not a shadow of suspicion can be attached either to his eye or his judgment; but it is perhaps possible that some source of deception may exist in his instrument, such as appears to have given rise to the supposed satellite of Venus in the last century. We shall soon, at any rate, know more about it. Should the existence of these minute points be established, the most natural supposition, of course, will be, that Sirius is accidentally projected on a background of small stars at an incalculably greater distance; and this idea would not be negatived by any apparent general displacement, which would be referred to the proper motion of the large star. Should, however, any mutual change of position be detected among the *comites*, a wide field would be opened for research among the fortunate possessors of competent telescopes. The question of native or reflected light would of course be a difficult one to deal with—its solution would, in fact, be impossible in the case of orbits highly inclined to our line of vision; but if bodies exist whose revolutions carry them from side to side, or nearly so, with respect to the central luminary, any periodical variation of light connected with their positions in

* Thirteen only had been discovered by him at the date of the presentation, February, 1861. Another was added in the following May.

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their orbits would, as indicating the existence of phases resulting from reflection, give sufficient evidence of their planetary nature.

ECLIPSES.

A considerable solar eclipse, in the afternoon of May 17th, will begin at 5h. 42m., Greenwich; 5h. 41m., Cambridge; 5h. 37m., Oxford; 5h. 26m., Liverpool; 5h. 18m., Edinburgh; 5h. 13m., Dublin. From these data such of our readers as may wish to observe the first contact may make a sufficient approximation to the time at their respective situations. The magnitude of the eclipse varies from 0·286 of the sun's diameter at Dublin to 0·349 at Edinburgh. A partial obscuration of this kind is not calculated to exhibit any remarkable phenomenon, though the projection of the rugged lunar mountains upon the vivid background of the sun may be interesting. In a large partial eclipse, 1793, September 5, Schröter and his assistants saw most evidently, with reflectors of 7 and 13 feet, but especially the latter, the globular form of the moon, as indicated by a feeble gray illumination of about 1′ in breadth, gradually fading inwards from the limb. This was, however, more probably an illusion arising from the dazzled state of the eye, than, as Schröter supposed, a result of refraction through a lunar atmosphere.

Our readers may be reminded in time that there will be a total lunar eclipse on June 1; the penumbra, or gradual enfeebling of the moon's light by the partial interposition of the earth, will begin about 8h. 49m.; the first contact with the actual shadow will occur 57m. afterwards.

PLANETS OF THE MONTH.

Mercury may now be looked for in the evenings with a fair prospect of success; its greatest elongation from the sun takes place on the 19th, when it also attains a N. declination of more than 25°. Its diameter at that time will be about 8″.

Venus will be, as she has been for some time, more beautiful to the naked eye than interesting in the telescope; her distance, though diminishing, being still comparatively considerable, with a diameter increasing from 12″·6 to 15″·8 through the month; and the form of her disc, about three-quarters enlightened, not being especially pleasing.

Jupiter will be very conspicuous, and the changes in the belts, and the disturbances in the equatorial region, may be studied with great advantage on so broad a disc, whose diameter decreases during the month from 41″·2 to 38″·8.

The ring of Saturn is undergoing a temporary diminution in breadth, in consequence of the direction of the earth's annual

motion; but the decrease will soon terminate, and be succeeded by a rapid opening during the winter months. The N. side is the one now visible, and as the sun is rising steadily above its plane, an evident shadow is cast on the opposite side upon the globe, or *above* it, in an inverting telescope. A good instrument will show a trace of the principal (or Ball's) division. The satellites will be objects of interest; but amateurs should be careful not to be deceived by the neighbourhood of small stars, which may readily be mistaken for them; as, on the other hand, allowance is to be made for the frequent invisibility of one or more in front of or behind the body of the planet. 3¾ inches of aperture will probably bring out, in favourable weather, the five old satellites, but they will require to be carefully looked for. They will not, under present circumstances, deviate much from the general direction of the ring, and the smallest three of those five (*Rhea*, *Dione*, and *Tethys*) will never lie very far from the ends of it, their greatest elongations being respectively 9·6, 6·9, and 5·4, if the radius of the planet is assumed as unity. *Titan*, the largest, reaches a distance of more than 22 radii, and *Japetus*, the second in brightness, but the outermost in order, upwards of 64.

The variable light of this satellite in different parts of its orbit, being brightest when W. of Saturn, and the irregularity of that variation, were discovered by Cassini. Schröter found the three smaller ones likewise variable, but in a reverse direction; and a suspicion of the same kind crossed my own mind last year with regard to *Titan*. The possessors of powerful telescopes have now a favourable opportunity for studying these curious, though minute phenomena.

TRANSITS OF JUPITER'S SATELLITES.

May 5th, the shadow of II. leaves the disc at 9h. 24m.—6th, I. emerges at 9h. 40m., followed by its shadow at 10h. 14m.—12th, the shadow of II. enters at 9h. 28m.; the satellite, at that time on the disc, will leave it at 10h. 34m., followed by the shadow at 11h. 58m.—13th, I. will be in transit from 9h. 14m. till 11h. 27m., its shadow from 9h. 55m. till 12h. 9m.—19th, the shadow of III. will pass off at 9h. 18m.; II. will enter at 10h. 23m., its shadow at 12h. 3m.—20th, the transit of I. begins at 11h. 1m.; of the shadow, 49m. later.—26th, III. finishes its transit at 9h. 34m., its shadow not entering till 10h. 49m.: II. enters at 12h. 43m.—29th, I. passes off at 9h. 29m.; its shadow at 10h. 27m.

One 6-mag. star only will be occulted during the month, 60 Cancri. May 23rd, 11h. 37m.

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PROCEEDINGS OF LEARNED SOCIETIES.

BY J. W. TEGETMEIER.

CHEMICAL SOCIETY.

ARTIFICIAL FORMATION OF BENZOIC ACID.—A paper was read on this subject by Mr. A. H. Church, who, in the course of some experiments on the action of sodium-amalgam upon chloride of phenyle, had obtained some very interesting results. Chloride of phenyle is first prepared by acting upon benzole with a chlorinating mixture of hydrochloric acid and bichromate of potash. The chlorinated body thus formed is a mixture, chiefly consisting of chloride of phenyle and the hydrochlorate of that compound, and when acted upon by a hot alcoholic solution of potash, yields ordinary carbolic (or phenic) acid—

$$C_{12}\,H_5\,Cl + KO,\,HO = KCl + C_6\,H_5\,O,\,HO.$$

From the carbolic acid thus formed may be made sulphophenic acid, and then sulphophenate of baryta. This salt, dried and mixed with half its weight of cyanide of barium, yields (in very minute yet unmistakeable traces) cyanide of phenyle, also called benzonitrile: the reaction is as follows:—

$$C_{12}\,H_5\,O,\,BaO,\,2SO_3 + Ba\,Cy = 2\,(BaO,\,SO_3) + C_{12}\,H_5\,Cy$$
$$(C_{12}\,H_5\,Cy = C_{14}\,H_5\,N).$$

Benzonitrile, boiled with potash, is resolved into benzoate of potash and ammonia. Mr. Church proved the identity of the carbolic and benzoic acids, formed as above described, with the usual states of these substances.

ANALYSIS OF THE RED CHALK OF HUNSTANTON.—A paper was read by Mr. A. H. Church on "The Composition of Red Chalk." The colouring matter of the chalk is sesquioxide of iron, which sometimes amounts to as much as thirty-six per cent. in the darkest and hardest nodules. Mr. Church considered that the absence of sulphuric acid in any form from the chalk itself, and from the water percolating through it, negatived the idea of a pyritic origin for the iron-oxide. If the proportion of iron-oxide to carbonate of lime be not greater than 4:9, strong ignition of the finely-powdered mineral yields a very dull olive-green substance, to which Mr. Church gives the formula, $3\,CaO,\,Fe_2\,O_3$—a ferrite of lime, which may possibly be of some value as a cheap and indestructible green pigment.

ATOMIC WEIGHTS OF NICKEL AND COBALT.—Dr. Russell has added another to the elaborate researches into the equivalent numbers of these two closely-allied metals: he comes to the conclusion that they are identical. The numbers obtained were:—

Cobalt 29·37.
Nickel 29·369.

A NEW DERIVATIVE OF FORMIC ACID.—The law of "homologous series" announced by the great chemist Gerhardt, is constantly aiding the discovery of new and interesting organic substances. Dr. A. W. Hofmann has succeeded in obtaining one of the missing terms of what is called the *formic* series, by a simple and usual process. Formic ether, $C_4 H_5 O, C_2 H O_3$, is saturated with ammonia gas, and heated for some time in a closed tube to the boiling-point of water. Formiamide and alcohol are thus produced:—

$$C_4 H_5 O, C_2 H O_3 + N H_3 = C_2 H O_2, H_2 N + C_4 H_5 O, HO.$$

Formiamide is ammonia, in which the complex group or radicle formyle, $C_2 H O_2$, occupies the place of one atom of hydrogen, thus:—

$$\text{Ammonia } \left.\begin{matrix} H \\ H \\ H \end{matrix}\right\} N. \qquad \text{Formiamide } \left.\begin{matrix} C_2 H O_2 \\ H \\ H \end{matrix}\right\} N.$$

Formiamide is an oily liquid, which may be distilled *in vacuo* without change. We may best show the typical importance of this new body by a table indicating its relations to the formic and acetic series. These series being homologous, it will be seen that the three formulæ of the lower line differ from the three over them by $C_2 H_2$:—

ACIDS.	AMIDES.	NITRILES.
Formic Acid $C_2 H_2 O_4$	Formiamide $C_2 H_3 O_2 N$	Formonitrile $C_2 H N$
Acetic Acid $C_4 H_4 O_4$	Acetamide $C_4 H_5 O_2 N$	Acetonitrile $C_4 H_3 N$

April 16.

DYES FROM NAPHTHALINE.—A paper was read by Messrs. W. H. Perkin, and A. H. Church, "On some Derivatives of Naphthylamine." Like the base aniline ($C_{12} H_7 N$) the analogous base naphthylamine ($C_{20} H_9 N$) yields several beautiful colouring matters. One of these, discovered by the authors in 1856, they have now submitted to a more complete examination. It is a crystalline substance of a deep crimson colour by transmitted light, and having a brilliant green metallic reflection. It melts at 136° C. It is made by dissolving in water two equivalents of hydrochlorate of naphthylamine, and adding to the solution one equivalent of nitrite of potassium, and one of hydrate of potassium, dissolved in another portion of water. The red precipitate thus formed is purified by recrystallization from alcohol. In accordance with its mode of formation and apparent constitution, very numerous analyses of this product led to the formula $C_{40} H_{15} N_3$, which may be thus represented—

$$\left.\begin{matrix} C_{20} H_7 \\ N''' \end{matrix}\right\} N$$
$$\left.\begin{matrix} H \\ C_{20} H_7 \end{matrix}\right\} N$$

two equivalents of naphthylamine joined together by the substitution of one equivalent of nitrogen for three equivalents of hydrogen.

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The salts of this base, named "azodinaphthyldiamine," present a most exquisite and rich violet tint, which is shown whenever an acid is added to the base in solution, which itself is of an orange-red colour. The authors describe various hydrochlorates, sulphates, etc., presenting many interesting characters. The basic hydrochlorate, for instance, occurs in golden-brown quadrilateral prisms, which are very beautiful when viewed under the microscope in polarized light. The base itself, as precipitated from its solution by water, is a splendid scarlet powder.

The authors have obtained many interesting derivatives of azodinaphthyldiamine. Among these is a second base, obtained by the action of hydrogen on the original substance. Its chief character is the peculiar blue-green colour which it assumes when oxidized. Messrs. Perkin and Church have also obtained "benzoylazodinaphthyldiamine,"

$$\left.\begin{matrix} C_{20}H_7 \\ N'' \end{matrix}\right\} N$$
$$\left.\begin{matrix} C_{14}H_5O_2 \\ C_{20}H_7 \end{matrix}\right\} N$$

and a still more complicated product whose name is worthy of record, if for no other reason, on account of its singular length, "azodinaphthyldicitraconamic acid."

LITERARY AND PHILOSOPHICAL SOCIETY OF MANCHESTER.—*March* 5.

(MATHEMATICAL AND PHYSICAL SECTION.)

In illustration of the abnormal character of the season, two barometric curves, neatly laid down on engraved forms by Mr. Sidebotham, from observations made by him at Ashton-upon-Mersey during the months of January and February last, and a summary of meteorological observations taken at Thelwall by Mr. Atkinson, F.G.S., during the month of February, were communicated to the Section. The mean height of the barometer at Thelwall for February, reduced to 32° Fahr., and to mean sea-level, had the unusually high value of 30·218 inches; the mean temperature was 42·5°; and the total fall of rain was only 0·811 inches. Mr. Baxendell communicated a table which he had calculated, showing the monthly sums of the oscillations of mean daily temperature at Greenwich during the thirteen years, 1848—60; and also the mean daily values for the different months. The mean monthly results were as follows:—

	°		°
January	102·8	July	82·8
February	84·9	August	78·4
March	83·4	September	72·3
April	90·6	October	84·4
May	83·9	November	94·5
June	87·3	December	107·1

The curve laid down from the above numbers differs considerably

from that of any other element of temperature, the principal maximum of disturbance occurring in December, and the principal minimum in September; and it is perhaps worthy of remark that the course of this curve appears to bear a well-marked relation to the annual progress of the growth and decay of plants, the period of maximum disturbance of mean daily temperature corresponding with that when the vital principle in plants is least active; and the time of minimum with that when the ripening of the more important cereals and fruits takes place. Mr. Baxendell also drew attention to the attempt which is now being made to organise an association for the systematic observation of variable stars, according to the plan described by Mr. Knott in our last Number. The recent results of spectral analysis tend to show that the light of the sun has a general resemblance to that of the class of stars to which nearly all the known variables belong, and thus give additional weight to the probability that it may also be slightly variable. Professor Clifton made a communication, in which he endeavoured to show that the principles of the mechanical theory of heat afford an explanation of phenomena attending the production of light by bodies, either when this production of light is due to incandescence or to fluorescence. His remarks and explanations were illustrated by a series of highly-interesting experiments.

Dr. Joule's Sensitive Thermometer.—Dr. Joule exhibited an exquisitely sensitive air thermometer, capable of being affected by the $\frac{1}{1000}$ of a centigrade degree of heat. The construction is thus described:—A glass vessel in the shape of a tube, two feet long by four inches in diameter, is divided longitudinally by a blackened pasteboard diaphragm, leaving spaces at the top and bottom, each little over an inch. In the top space a piece of magnetized sewing needle, furnished with a glass index, is suspended by a single filament of silk. It is evident that the arrangement is similar to that of a bratticed coal-pit shaft, and that the slightest excess of temperature on one side over that on the other must occasion a circulation of air, which will ascend on the heated side, and after passing across the fine glass index, descend on the other side. It is also evident that the sensibility of the instrument may be increased to any required extent, by diminishing the directive force of the magnetic needle. I purpose to make several improvements in my present instrument; but in its present condition, the heat radiated by a small pan, containing a pint of water heated 30°, is quite perceptible at a distance of three yards. A further proof of the extreme sensibility of the instrument is obtained from the fact that it is able to detect the heat radiated by the moon. A beam of moonlight was admitted through a slit in the shutter. As the moon (nearly full) travelled from left to right, the beam passed gradually across the instrument, causing the index to be deflected several degrees, first to the left and then to the right. The effect showed, according to a very rough estimate, that the air in the instrument must have been heated by the moon's rays a few ten-thousandths of a degree, or by a quantity, no doubt the equivalent of the light absorbed by the blackened surface, on which the rays fell.

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MICROSCOPIC SOCIETY.

The annual *soirée* of this Society was held at King's College on the 8th April, when a large company was assembled, and a great display made of first-class instruments and objects. Mr. Ross exhibited a considerable number of objects with binocular and single microscopes in a very splendid way. Messrs. Smith and Beck did the same, and introduced two important novelties, the one a new object-glass of $\frac{1}{10}$ inch focal length, and the other a binocular apparatus as a substitute for single lenses in microscopic dissections, the examination of large objects, or any delicate operation for which the watchmaker's or engraver's eye-glass is usually employed. The new $\frac{1}{50}$th was exhibited with the 3rd and lower eye-pieces upon a Podura scale, giving with the former a power of 3,000 linear, and, so far as we could judge under unfavourable circumstances, accurate definition. An $\frac{1}{4}$th, showed by the same firm, with a third eye-piece, left nothing to be desired, either for light or definition. The new binocular dissecting lens, or whatever it may be called, is an admirable invention. It bears some resemblance to a pair of spectacles mounted upon a stand, so as to permit its adjustment to any height. The two lenses are ground so as to act like corresponding portions of a single lens of large dimensions; and as every one knows that a common pair of spectacles produces fatigue and inconvenience which is not felt on looking through the large magnifying glasses used for viewing pictures or engravings, the superiority of the new instrument will be understood when we say that it bears a close resemblance to the effect of the latter, except that the vision is easier and more perfect. Messrs. Powell and Lealand won universal admiration by showing the cell rotation of the Valisneria with their $\frac{1}{25}$ inch object-glass. As Dr. Carpenter observes, this wonderfully perfect glass displays the movements of the protoplasm, which are not visible by ordinary means, but which, having been once seen and understood by the operation of the $\frac{1}{25}$, may probably, we should think, prove amenable to much lower powers properly employed. With this $\frac{1}{50}$th the field is as light and the definition as perfect as that of any large object seen with a 2-inch glass. Messrs. Horne and Thornthwaite made a very interesting miniature scene, by exhibiting the electrolytic crystallization of the new metal Thallium under an excellent microscope; and Mr. Farrants showed an exquisitely-written Lord's Prayer, surrounded by a border of ornamental lines, executed with Mr. Peter's writing machine. Mr. Burr exhibited a section of the leaf of the *Welwitchsia mirabilis;* Dr. Miller showed the *Conochilus volvox;* and Messrs. Crouch, Pillischer, Murray and Heath, and many others, contributed to an extremely interesting display.

ROYAL ASTRONOMICAL SOCIETY.—*April 10th.*

Mr. E. J. Stone read a paper on the Parallax of the Sun, as determined from observations of Mars at the opposition of 1862. The usually received value of the Sun's Equatorial Horizontal Parallax is

8″·57, but M. Leverrier has recently stated that it must be increased, and his examination of the Solar Tables gives 8″·95 for its value. Mr. Stone has discussed the observations of Mars made at Williamstown, Victoria, Australia, and Greenwich, and from twenty-two separate determinations between August 25th and November 12th, 1862, obtained a result of 8″·977, with a probable error of 0″·032. The Astronomer-Royal stated that he had been favoured by M. Otto Struve with the result obtained by M. Winnecke from the discussion of the observations of Mars at Pulkowa and the Cape of Good Hope, which gave 8″·96 for the Sun's Parallax, a value so remarkably accordant with the two others that it was clear we must consider the Sun as three or four millions of miles nearer to us than we had hitherto done. Mr. Airy then proceeded to give an oral account of the observations on Stellar Spectra made at the Royal Observatory, describing the apparatus, and showing a diagram of the spectra observed. The line F of Frauenhofer was generally seen indicating iron in most stars, the sodium line D in two, and a line nearly, but not quite coinciding with G in many. The star α Orionis appeared most like our sun, but generally the stars seemed not to be so complex in constitution. Mr. Huggins inquired whether the diagram showed all the lines observed, or only the principal ones, as in his researches, which had been communicated to the Royal Society, he obtained with, as he thought, more delicate apparatus, more delicate results. The star Capella, which in the Astronomer-Royal's diagram had only two bars, he had observed to be full of fine lines, and seemed to resemble the Sun very closely, as also did Aldebaran. Sirius had lines C and B strongly marked. He and Dr. Miller had photographed the spectra of Sirius and Capella, with a view to the relation which existed between the heat and the extent of invisible rays. Mr. Carpenter, the observer at Greenwich, stated that more lines were seen in the spectra, but only the measured ones inserted in the diagram. M. Otto Struve, after some introductory remarks by the Astronomer-Royal, described a curious anomaly in the earth's effect on a plumb line in the neighbourhood of Moscow. It was found by M. Schweitzer, Director of the Observatory there, that a difference of 8″ in the latitude existed between that element determined by direct observation and by triangulation from distant well-known points; and by observations at very numerous stations in the neighbourhood, it was found that a line existed to the south of Moscow where observations of all kinds agreed, but that to the north there was a difference in one direction, and to the south in another; and that in the direction of the meridian the tract of country affected seemed about seventy-four miles in extent, but that in the line of east and west the extent was greater, and had not yet been reached. The effect was that plumb lines at the two extremes converged one-fiftieth part less that they should, and the only explanation which could be given was that a large trough of the earth was less in density than the surrounding country, as there were no mountains nor large surface of sea to disturb the general effect of gravity, as those features were sometimes known to do.

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ENTOMOLOGICAL SOCIETY.—*March* 2.

The Stingless Honey Bees of America.—Mr. Smith, the president, read a memoir on the species of bees found in the New World. Except the European honey bee, *Apis mellifica*, which had been introduced and naturalized in America, no species of Apis occurred in that large continent. But their place was supplied by stingless bees of the genera Trigona and Melipona. The honey collected by these bees varies very much in quality; and from an examination of their mouths, Mr. Smith was of opinion that the different species selected their honey from different species of flowers. We may remark that the yellow coloured variety of the European bee, known as the Ligurian bee, has been recently introduced in the United States, and is spreading rapidly.

ANTHROPOLOGICAL SOCIETY.—*April* 7.

On a Small Human Brain.—Dr. Gore furnished an account of the smallest adult human brain on record. The brain of the adult male averages forty-nine ounces; in females the average is forty-three and a half ounces. The female, whose brain was described, was forty-two years of age, and without any symptom of disease. She was five feet high, and her intellect was infantile. The brain without the membranes weighed ten ounces five grains, being the smallest mature brain on record.

ROYAL INSTITUTION.—*April* 17.

Fertility of Fish.—Mr. Frank Buckland delivered a lecture on the artificial culture of fish, by permitting the ova to develope in shallow boxes supplied with a constant flow of water. Mr. Buckland has recently ascertained the amount of ova in several species of fish, by counting the number in a given weight, say ten or twenty grains, and then weighing the entire roe. The following are the results:—

Salmon, to each pound the fish weighs, about	1,000 ova.
Trout of one pound weight	1,008 „
Herring of half pound weight	19,840 „
Perch of half pound weight	20,592 „
Jack of four and a half pounds weight ...	42,840 „
Mackerel of one pound weight	86,220 „
Sole of one pound weight	134,466 „
Brill of four pounds weight	239,770 „
Turbot of eight pounds weight	385,200 „
Roach of three quarters of a pound weight	480,000 „
Cod of fifteen pounds weight	4,872,000 „

NOTES AND MEMORANDA.

MR. GLAISHER'S ASCENTS.—The ninth of these incidents took place at the Crysta Palace on the 31st of March, at 4h. 16m. p.m., the temperature being 50°. At one mile elevation the temperature was 33½°; at two miles, 26°; three miles, 14°; three miles and three-quarters, 8°. Then a warm current was encountered, and the temperature rose to 12°. At four miles and a-half, temperature zero. In descending, 11° at three miles; cold current entered, and it fell 7°. At two miles, rose to 18½°; 25½° at one mile, and 42° on reaching earth. The air was dry before leaving the earth; at heights above two miles very dry; exceeding four miles dew point fully minus 40°. This, with previous ascents, shows that the theory of a decline of 1° for each 300 feet elevation must be abandoned. At one mile the deep roar of London was heard distinctly, and a murmur at greater elevations. At three and four miles views were wonderful, extending to Margate, Dover, Brighton, Yarmouth, etc. Railway trains looked creeping things, like caterpillars, and all the country looked so calm as to appear artificial. Looking downwards, patches of cumulus cloud appeared resting on the earth, and had the aspect of shining wool. The blackness creeping over the land at sunset was remarkable, while the sun was still shining on the balloon. The tenth ascent was made on the 18th of April, when he found sensitive photographic paper did not colour as much in half an hour in the full sun at three miles' elevation as in one minute at Greenwich. He likewise made spectroscope experiments, and reports that at four miles, and upwards to four and a-half, "when the light entered the slit from the sun itself the lines in the spectrum were innumerable; all those I saw before leaving the earth were visible, and many more. The nebulous lines (H) were both seen, and the spectrum a good deal lengthened at the violet end; at the red end (A) was visible. When the light came from the sky in the immediate vicinity of the sun, the spectrum was shorter, but all the lines were visible from B to G. On passing from the sun the spectrum shortened very quickly, and when opposite to the sun there was no spectrum—in fact, no light at all."

DR. WALLICH'S AMŒBA.—Dr. Wallich obtained from Hampstead Heath an amœba not previously known as British, and resembling one found by him in Lower Bengal, in which "the villous portion of the ectosarc constitutes a means of permanent attachment to foreign bodies, such as confervæ and the like." The "villous patch" of those from Hampstead occupies from one-fiftieth to one-seventieth of the entire superfices, and is employed as a prehensile organ. The true pseudopodia do not seem to be projected from this area. In some specimens the contractile vesicle presented a reticulated appearance, probably from the occurrence of minute vacuoles. Size of large specimens, 1—50″. Dr. Wallich observes, "several circumstances render it probable that it may be a transient phase in the life history of the common amœba." This amœba is described in *Annals of Natural History*, from which we have extracted the above.

EMBRYOGENY OF COMATULA ROSEA.—Professor Wyville Thompson communicates to the Royal Society observations on the above subject. After complete segmentation of the yelk, a more consistent nucleus appears in the mulberry mass still contained in the vitelline membrane. The external portion of the yelk liquefies, and is absorbed into this nucleus, "which gradually assumes the form of the embryo larva, a granular cylinder contracted at one end, and girded with four transverse bands of cilia. This cylinder increases in size and transparency, and at last bursts through the vitelline membrane. Several changes take place, and the larva assumes somewhat the form of a kidney bean, the mouth answering in position to the hilum. It swims freely in the water, with a swinging, semi-rotatory motion, by means of its ciliated bands and posterior tuft of cilia." Ten minute calcareous spiculæ are then developed imbedded within the external sarcode layer of the expanded anterior portion. They are arranged in two transverse rings of five. They expand into ten plates, which at length form a trellis enclosing a dodecahedral space. Simultaneously with these plates, from seven to ten calcareous rings are developed, forming a chain passing from the base of the posterior row of plates backwards, and "ending by abutting against the centre of a large cribriform plate, which is rapidly developed close to the posterior extremity

of the larva." This formation finally becomes the jointed stem of the pentacrinoid stage. "After swimming freely for a time, 'averaging from eight hours to a week,' the larva becomes sluggish, and its form is distorted by the growing crinoid." The mouth and alimentary canal of the larva disappear, the stem lengthens, the rudimentary arms are seen, and at some stage of this process the creature becomes attached. Further details in *Proceedings of the Royal Society*, Vol. xii., No. 54, p. 426.

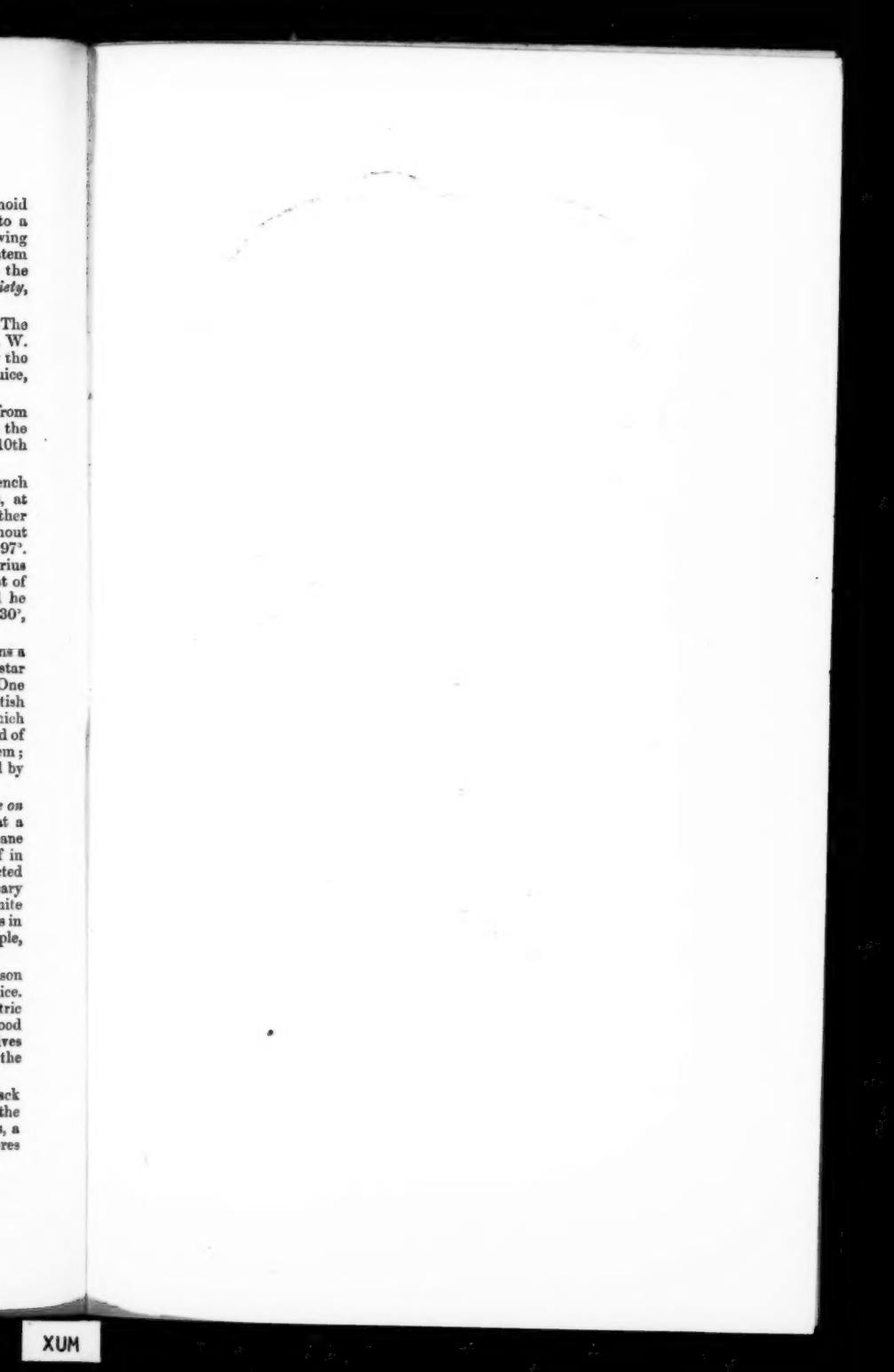
ARTIFICIAL PRODUCTION OF FIBRIN FROM ALBUMEN AND GLUTEN.—The *Proceedings of the Royal Society*, No. 52, contain an important paper by A. W. Smee, jun., on the above subject. He finds that fibrin can be produced by the direct action of oxygen on albumen, and that "gluten dissolved in gastric juice, and then oxidised at the ordinary temperature, yields fibrin."

78TH PLANET.—*Astronomische Nachrichten*, No. 1408, contains a letter from Dr. R. Luther, of the Bilk Observatory, announcing the discovery by him, on the 15th of March, of the 78th planet, which he names Diana. It is of the 10th magnitude.

MORE COMPANIONS OF SIRIUS.—M. H. Goldschmidt informs the French Academy that he has been able to see Alvan Clark's companion of Sirius, at intervals, with a telescope of 46 lines aperture. He also observed several other minute stars from 15″ to 1′ from Sirius. One of these, which he says is without doubt a companion, is south of that discovered by Clark: angle of position, 95°—97°. This he found visible "*pour moments.*" A second star on the line between Sirius and A. Clark's companion, was an almost imperceptible point of light. East of Sirius, and of companion No. 1 F, he finds another little star, No. 3 D; and he adds, "the star, No. 4 E, has an angle of position of 170°, and No. 5 of 25° to 30°, and are distant from Sirius in the proportion of (*par rapport de*) No. 1."

STAR SPECTROSCOPES.—The *Astronomische Nachrichten*, No. 1408, contains a description of an apparatus made by Steinheil for examining and measuring star spectra, which appears more convenient than that of Jansen used by Secchi. One of the new pattern was forwarded last autumn to the Hon. G. Lettsom, British Envoy at Monte Video. Two other spectroscopes are described in *Cosmos*, which offer the advantage of *direct* vision. The one, used by Amici in 1860, composed of two prisms of crown glass, having one prism of borosilicate of lead between them; the other made by M. Hoffman, of several prisms of flint glass, compensated by several prisms of crown.

LARGE CONCAVE MIRRORS.—In the *Supplement to the Practical Treatise on Optical Instruments*, by Andrew Pritchard, published in 1850, it is stated that a burning mirror was exhibited to the British Association, formed of a circular pane of plate-glass, three-sixteenths of an inch thick, and three feet and a-half in diameter. This was fitted to a cast-iron box one inch deep. Air was extracted from the box, and the atmospheric pressure on the glass pane gave it the necessary curvature, and it was then able to reflect and converge enough heat to ignite various articles and roast meat. Such a mirror, silvered by Liebig's process, as in telescope mirrors, might be useful for many scientific purposes, as, for example, experiments on the heat of the moon.

PHYSIOLOGY OF THE STOMACH.—Dr. Pavy gives a simple physical reason why the stomach is not destroyed by the solvent power of its own gastric juice. He says that in a state of health the blood is always alkaline, and the gastric juice acid. The introduction of food into the stomach causes an influx of blood to that organ, as well as determines a secretion of gastric juice, and he conceives that the alkalinity of the former fluid protects the stomach from the action of the latter.

BLACK RAIN IN SCOTLAND.—On March 14, at half-past eight p.m., black rain fell at Blackford, near Auchterarder, Perthshire. A minute quantity of the deposit, dried on a microscopic slide, exhibits a few angular silicious particles, a multitude of exceedingly small dark particles, without structure, and some fibres of vegetable appearance, but nothing distinctive that we could make out.